Official Proceedings

OF THE

Western Railway Club

FOR THE

Club Year 1907-1908

The Club meets the third Tuesday of each month, except June, July and August.
The Club Year ends with the meeting in May.

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WESTERN RAILWAY CLUB

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at Assembly Hall, Fine Arts Building, September 17, 1907. President C. A. Seley in the chair. The meeting was called to order by the President at 8 P. M. The following members registered:

Anderson, Olaf	Henderson, T. D.	Richards, R. C.
Arlein, E. J.	Hibbard, M. W.	Rowley, S. T.
Axtell, Ford	Hill, C. P.	Seaberg, F.
Baker, F. L.	Hincher, W. W.	Seley, C. A.
Carpenter, Henry C.	Hyland, Chas.	Sharp, W. E.
Callahan, J. P.	Jeffries, B. H.	Shumate, F. D.
Cardwell, J. R.	Kadish, R. B.	Slaughter, H. W.
Christenson, A.	Kelley, H. D.	State, R. E.
Crawford, J. G.	Kucher, T. N.	Stimson, O. M.
Crownover, G. M.	Langan, J. W.	Stocks, W. H.
Dodd, T. L.	LaQuay, M.	Taft, R. C.
Endsley, L. E.	La Rue, H.	Tawse, W. G.
Ensign, H. W.	Linn, H. R.	Taylor, J. W.
Estrup, H. H.	Little, J. C.	Thomas, C. W.
Flavin, J. T.	Lowder, R. S.	Thompson, E. B.
Fogg, J. W.	McAlpine, A. R.	Throll, John
Fry, C. H.	Mackenzie, D. R.	Thurnauer, Gustav
Furry, F. W.	Michael, L. P.	Tratman, E. E. R.
Gardiner, S. A.	Mills, Geo. F.	Vincent, M. M.
Gilmore, Frank	Midgley, S. W.	Warnock, T. E.
Gold, E. H.	Monroe, M. S.	Webb, E. R.
Goodnow, T. H.	Peck, C. L.	Young, C. B.
Haig, M. H.	Peck, P. H.	Zealand, T. H.
Hatch, H. B.	Park, H. S.	

President Seley: I am very glad, gentlemen, to welcome you back to the regular meetings of the Club after the usual Summer vacation and holidays and rest that railroad men get during these hot months, and trust that our meetings during the fall will be

enjoyable and well attended, with everyone pulling as hard as they can for the success of the Western Railway Club.

The minutes of the last meeting have been printed and distributed. Unless there are errors or objections they will stand approved as printed.

The Secretary: Mr. President, I have the usual membership report:

MEMBERSHIP STATEMENT.

Membership, May, 1907		1,400
Resignations	25	
Dropped, non-payment of dues	2	
		1,373
New members approved by Board		39
Total Membership		1,412

NEW MEMBERS.

Name. Address.	Proposed by
Chas. W. Peterson, C. D., Engr. Dept., Rock Island R. R., Chicago	A. K. Shurtleff
Geo. N. Boyd, West. Repr., Pantasote Co., Chicago	D. E. Bonner
Anthony Saddler, For. Boiler Maker, C. & N. W. Ry., So. Kaukauna, Wis	S. C. Graham
W. F. Carroll, Rd. For. of Engines, C. & N. W. Ry., Waseca, Minn.	W. E. Dunham
T. T. Cavanaugh, Scully Steel & Iron Co., Chicago	W. H. Dangel
F. C. Shafer, G. F., N. Y. C. & St. L. Ry., Chicago	Geo. James
L. W. Barger, Standard Car Truck Co., Chicago	J. C. Barber
G. S. Chiles Spec. Appr., L. S. & M. S. Ry., Collinwood, Ohio	G. W. Bissell
G. L. Dolan, Engineer, C. & E. I. Ry., Chicago	W. G. Tawse
C. W. Gennet, Jr., Atha Steel Castings Co., Chicago	G. C. Isbester
O. C. Hayward, Sec'y, Towsey Varnish Co., Chicago	R. B. Kadish
W. A. Jones, Penna. R. R., Ft. Wayne, Ind	D. F. Crawford
R. C. Price, C. I. & S. Ry., Gibson, Ind	S. T. Rowley
G. N. Sweringen, Mgr. Sales, McMaster-Carr Supply Co., Chicago	J. W. Motherwell
W. H. Winterrowd, Spec. Appr., L. S. & M. S. Ry., Elkhart, Ind.	A. R. Ayers
H. A. Gardner, Elec. Engr., C., B. & Q. Ry., Chicago	C. B. Young
G. H. Rice, City Electrician, Chicago, Ill	P. H. Peck
R. W. Stephens, Train Master, Belt Ry., Chicago	P. H. Peck
P. T. Dunn, M. M., Penna. Lines, Chicago	P. H. Peck
Wm. V. McNamara, Car For., Williamson, W. Va	D. G. Cunningham
E. P. Gould, Chicago Bailey Co., Chicago	H. T. Bentley
J. R. Davies, A. P. A., Chicago City Ry., Chicago	W. W. Hincher
T. G. Averill, Marvin Mfg. Co., Franklin, Pa	C. B. Holdrege
M. Yoshino, Supt. R. S., Manchurian Ry., Tairen, Manchuria	C. M. Muchnic
Y. Yamamoto, Mech. Engr., Manchurian Ry., Tairen, Manchuria	C. M. Muchnic
Olaf Anderson, Draftsman, C. & N. W. Ry., Chicago	T. E. Warnock
R. S. Lowder, Draftsman, C. & N. W. Ry., Chicago	J. C. Little
L P. Michael, Draftsman, C. & N. W. Ry,Chicago	J. C. Little
M. E. Towner, C. C. to V. P., C., R. I. & P. Ry., Chicago	C A. Seley

Name	Address	Proposed by
J. L. Berman,	Northwestern Elev. R. R., Chicago	C. A. Seley
A. J. Ashton,	C. C.-Supt. Tel., C. & E. I. R. R., Chicago	F. H. Rutherford
L. W. Wallace,	Instructor, Purdue University, Lafayette, Ind.	L. E. Endsley
W. S. Furry,	Ohio Injector Co., Chicago	F. W. Furry
G. W. Seidel,	Supt. Shops, C., R. I. & P. Ry., Silvis, Ill.	C. A. Seley
Chas. H. Johnson,	G. F., Loco. Dept., Mich. Cent. R. R., Chicago	E. R. Webb
C. L. DeMuralt,	Muralt & Co., New York, N. Y.	Chas. Ducas
F. A. Lawler,	Crucible Steel Co., Chicago	F. Baskerfield
W. N. Connor,	Gen. Inspr., C. & E. I. R. R., Chicago	H. H. Estrup
C. Stanley Sale,	Railway Age, Chicago	Wm. Forsyth

RESIGNATIONS.

J. B. Barnes, S. M. P., Wabash R. R., Springfield, Ill.
D. E. Bonner, The Pantasote Co., Chicago, Ill.
J. S. Bridges, Economy Loco. Sander Co., Baltimore, Md.
C. E. Cardeu, Thos. Cook & Co., London, England.
F. C. Carrill, Jacksonville, Ill.
Jas. Dickson, G. F., C., B. & Q. Ry., Quincy, Ill.
Kuno von Eltz, R. H. F., Mich. Cent. R. R., Michigan City, Ind.
C. D. Ettenger, Murphy Varnish Co., Chicago.
G. W. Farmer, Foreman, A. T. & S. F. Ry., Ft. Madison, Ia.
T. P. Felix, Latrobe Steel & Coupler Co., Melrose Park, Ill.
Chas. Hankole, Foreman, C. & N. W. Ry., Eagle Grove, Ia.
C. F. Heywood, Latrobe Steel & Coupler Co., Melrose Park, Ill.
F. C. Kneller, G. F., C., M. & St. P. Ry., Milwaukee, Wis.
C. E. Leach, New York Air Brake Co., New York, N. Y.
W. S. McKee, American Brake Shoe & Fdy. Co., Chicago.
David Meadows, Trav. Engr., Mich. Cent. R. R., St. Thomas, Ont.
C. M. Mendenhall, American Steel Foundries, New York City.
W. H. Myers, Latrobe Steel & Coupler Co., Melrose Park, Ill.
F. D. Palmer, Loco. Engr., C., B. & Q. Ry., Lincoln, Neb.
J. A. Peabody, Signal Engr., C. & N. W. Ry., Chicago.
H. F. Schumacher, C. C. Trans., C., L. S. & E. Ry., Chicago.
G. E. Van Wort, Murphy Varnish Co., Chicago.
H. D. Webster, Bayonne, N. J.
J. A. Whaling, Milwaukee, Wis.
F. H. Wilson, Asst. Supt., L. S. & M. S. Ry., Chicago.

DROPPED.

F. G. Howland, Shop For., B. & M. R. R., Havelock, Neb.
R. K. Peirce, Spec. Appr., C., B. & Q. Ry., Burlington, Ia.

I also have the report of the Auditing Committee as follows:

CHICAGO, ILL., Sept. 9, 1907..

To the President and Members of Western Railway Club,

GENTLEMEN: Your Auditing Committee has examined the books of the Secretary and Treasurer for the period May, 1906, to May, 1907, and find same correct.

Yours truly,

T. H. GOODNOW.
O. M. STIMSON.
HENRY LA RUE.
Committee.

THE SECRETARY: Those are all the reports I have, Mr. President.

PRESIDENT SELEY: The paper for the evening, prepared by Mr.

W. D'A. Ryan, entitled "Exposed versus Concealed and Semi-concealed Car Lights" was to have been delivered by him. Unfortunately Mr. Ryan has been taken ill, but fortunately for us a representative of his department in the person of Mr. G. H. Stickney has come to read this paper. I take pleasure in introducing Mr. Stickney.

Mr. G. H. Stickney: Mr. Chairman and Gentlemen: I received a telegram from Mr. Ryan the other day to the effect that he would not be able to come here and asking me to come to Chicago and say a few words for him in connection with the car lighting. I will endeavor to present the subject to you briefly, and tell you of the efforts that are being made toward solving the problems of car lighting which are now very actively engaging the study of a very large number of railroad men.

I have given some study to the subject as an assistant to Mr. Ryan, who has designed a particular type of reflector for the application of incandescent lamps to car lighting. I have discussed the question with Mr. Ryan so that I can perhaps cover the ground from the same standpoint that he would were he present.

The problem of which I propose to speak particularly is that of lighting the general body of the car; in other words, the general illumination provided for the comfort of the passengers. First, let us define the purpose for which we provide such light. The primary purpose of lighting a car is to provide for the comfort of the passengers and make the car a pleasant drawing room in which they can pass the time they are spending in travel. Of course there is a secondary purpose in lighting a car; that is, to give it an attractive appearance, so that passengers who see the car in a station or the public as they may see it passing through the country will notice the brilliantly lighted train and be attracted toward it; but in general the primary question is that of providing for the comfort of the passengers. It is this, in fact, that engages the skill and experience of the Illuminating Engineer. Considerable attention has been given recently to the subject and numerous suggestions and changes have been made, but there still seems to be room for improvement.

In taking up any lighting problem the physiological aspect should never be lost sight of. It is necessary to consider the eyes of the people who are using the light. The only way in which the lighting affects the passengers is through their eyes, outside of the questions of ventilation and heating. Perhaps the most common defect in car lighting is the glaring effect of lights of high intrinsic brilliancy. This is particularly noticeable when one is occupying one of the rear seats, so that there is a line of lights in front of the passenger which shines in his eyes, coming within his range of vision. Of course the low decking of the car makes it necessary to locate the lights relatively low, so that the lamp comes necessarily in the range

of vision. The light enters the eye at an angle at which the eye is not constructed to protect itself.

This point is illustrated by snow blindness which affects the eye not because the intensity of light is stronger than the light which comes from above, but because it enters the eye from a direction from which the eye cannot protect itself.

Now, the intrinsic brilliancy of a light source may be defined as the intensity of the light divided by the area of the source; that is, if we have two lights of equal intensity the one that has the smaller area is the more brilliant and the one that will cause the greater tiring effect. If we can enlarge the area of the light source, make the light, without changing the volume, come from a large surface, you can see immediately that it will be much easier on the eyes. If this be carried far enough one can even look directly into the light without being nearly so much affected as by a casual glance at a light of great intrinsic brilliancy. Fortunately increasing the source of light produces several other improvements. It improves the diffusion of the light, makes it easier to penetrate around bodies, cuts down harsh shadows and aids in making distribution over all points equal in intensity. It is very unpleasant when reading to have the lights situated so that the shadow of one's head, for instance, comes directly on the page. I think passengers have felt this defect quite seriously.

Now to come to the question of intensity. In nearly all illuminating engineering problems we find quite a wide range of variation in the opinion of those who are using the light as to the intensity of light that is necessary in order to perform a certain work or to see with a certain degree of fineness. Outside of the requirements of different conditions this variation of opinion necessitates considerable study of conditions in order to determine an intensity which compromises between the desirability of strong illumination and the cost. For economic reasons the intensity of artificial illumination almost always falls far below that of daylight. In car lighting there is a demand for quite a variation of intensity in a single car. For instance, a person who is reading requires considerable intensity of illumination, while a person who is whiling away his time and trying to sleep or rest would prefer a relatively low intensity. So, outside of the cost of illumination, we desire to make it possible to read easily with as low an intensity of illumination as possible. This condition also is facilitated by properly diffusing the light.

About a year and a half ago in connection with lighting one of the large stations of the country Mr. Ryan ran a series of experiments for one of the railroads, in which he lighted a high room by arc lamps suspended in the top of the room and also by arc lamps concealed so as to reflect the light on the roof and then downward into the room, no lamps being visible. Of course the latter method

was considerably more extravagant of light, but a committee of railroad officials who looked at the installation decided that the diffused illumination which was only two-thirds as intense as the direct illumination permitted them to see objects, and read more easily than the direct illumination, while the general effect was much pleasanter.

Another quality of illumination which should be considered in connection with the eyes is the color of the light. It is not absolutely essential that the light should be perfectly white or daylight in color, but it should approximate this color as nearly as possible, and if there is to be a variation it should be in the direction of the warm colors, such as yellow, for instance, to which people are accustomed, both in their ordinary indoor lighting and in the waning of daylight. The eye has been developed to its present form through the action of daylight and to some extent through the action of artificial lights to which the people have been accustomed and is therefore better able to act under such light. An excessive distortion of color should always be avoided. You could hardly expect the public to stand for an extreme monochromatic light. In some instances employes have been compelled to submit to such a distortion with the possibility of increasing color blindness, but the public whom it is desired to solicit and to draw to the custom of the railroad cannot be expected to submit to such color distortion.

In selecting an illuminant for a particular lighting problem we have found it desirable to make the power and capacity of the lighting unit bear some sort of a relation to the area to be illuminated. For instance, in a large, high building we would use a large powerful unit and in a small low building a correspondingly smaller unit. In cases of armory lighting, for example, we make a practice of grouping several arc lights together to form a single unit, while in a small room in order to obtain even illumination the lighting unit must be relatively small. So of all the electric lamps available the incandescent lamp lends itself most readily to car lighting.

There has been within the past few years some very considerable development going on in the construction of incandescent lamps. New materials have been discovered, which have made it possible to increase the efficiency of an incandescent lamp very considerably; whereas, up to about this present period it has been necessary to use a carbon filament which required the expenditure of from three to four watts for every candle power. It is now possible to use a Tungsten filament which requires approximately 1½ watts for a candle power; that is, a horizontal candle power. This increased efficiency will be of great aid to all classes of illumination where the incandescent lamp is applicable. The Tungsten lamp is particularly adapted to low voltage; that is, the electrical character-

istics are such that it can be best manufactured for 30 volts rather than for 110 volts at which the ordinary incandescent lights are run. The relation between the length and the diameter of the filament to produce proper electrical resistance is the determining factor. The hardest thing which we have had to overcome in constructing Tungsten lamps has been the brittleness of the material, so that the short, heavy filaments are most rugged and most suitable for car lighting work.

Mr. Ryan in taking up the problem used a lamp giving 17 horizontal candle power and consuming about 25 watts at a voltage of from 30 to 37.

Another point in connection with the incandescent lamp is the question of whether clear or frosted lamps should be used. The frosted lamp undoubtedly is much easier on the eye than a clear lamp when run without a protecting shade, but the frosted lamp falls off in candle power much more rapidly than a clear lamp and much more rapidly than a clear lamp would with an outer shade. This subject has been worked out theoretically and practically and a number of papers written on the subject. We have found it best to use a clear incandescent lamp and then protect the eyes by means of a separate shade. Mr. Ryan's car lighting fixture of which a sample has been installed here, consists of a steel diffusing screen placed above a row of incandescent lamps. The steel is finished with a white enamel, so as to give a highly efficient reflecting and diffusing surface. This design renders the lamp to a large extent independent of the finish of the car, whether dark or light, and at the same time permits enough light to fall on the deck of the car so that it will not appear dark or gloomy. Beneath the row of lamps is placed a long trough shaped shade of art glass. The purpose of this is to cut off the direct light of the lamps from the eyes of the passengers and reduce the intrinsic brilliancy, so as to conform to the conditions which we have previously outlined. This form of reflector provides a large area for the source and a low intrinsic brilliancy so that passengers may sit in a car without feeling the tiring and even injurious effects of a harsh lighting. It also provides for an even distribution of light throughout the car, so that one seat is not favored over another seat and harsh and disagreeable shadows are eliminated. In construction the reflector and all other parts are mounted upon a light metal framework, which is attached to the deck of the car. The ornamental casting around the diffusing surface finishes off the reflector and gives it a neat appearance. It also avoids an open space in which the dust and dirt would accumulate and spoil the appearance of the installation. The diffuser is of stamped steel, made in sections, so that the size of the unit may be varied for different conditions; for instance, in the body of the car a long reflector may be used varying anywhere from about two or three feet up to the entire length

of the car. This was made to provide flexibility in anticipation of the possibility that it might be desirable at some time to use one continuous reflector for lighting the car. As adapted at present the designs are merely the oval and the oblong shapes. The shade is a trough of art glass, which conceals the separate individual lamps from view, when it is desired to turn down the light, or reduce the intensity, part of the lamps may be cut out without its being noticeable that some of the lamps are not lighted. Each fixture is just one general source of illumination, whether all or only part of the lamps are in service. The dimensions of the six-light reflector are 48 inches long by 20 inches wide and 10 inches deep. The weight of the reflector is about 37 or 38 pounds, as constructed. In speaking of the advantages of the reflector I can best state it by quoting from Mr. Ryan's letter to me:

"1st. Softness and general diffusion of light, eliminating strong shadows.

"2d. Clear lamps can be used thereby materially increasing the life of the lamps and diminishing the initial and maintenance cost. It is a well-known fact that the difference in useful life between a clear and a frosted lamp is somewhere between 30 and 40 per cent. On railway trains particularly, frosted lamps accumulate a very large amount of smoke and dirt, so that the use of a clear lamp is a decided advantage which cannot be obtained by any other form of illumination with which I am personally familiar. For example, if the lamps are enclosed in a prism glass globe aside from the usual advantages of this glass you have a high intrinsic brilliancy in streaks.

"3d. Aesthetic. The apparatus can be made attractive in appearance and possibly save on first cost as compared with some of the quite elaborate fixtures now used in Pullman cars."

It is proposed to use for lighting a Pullman sleeper a six-lamp Tungsten light, of which it will take one for each section. This can be arranged so that the light may be turned down to any number of lamps less than six, depending on the connection which is provided. This combination running with the full number of lamps will take 150 watts of electrical power to a section or about three watts to a floor area. For a five section car 750 watts will be required for the illumination of the entire main body of the car, not counting, of course, the berth lights. This with the other lights of the car will probably bring the capacity up to in the neighborhood of 1,000 watts per car. An oval three-light fixture which takes comparatively half as much power as the six-light would be used in the smoking compartment. For lighting a day coach Mr. Ryan proposes to use six 3-light fixtures, which take for the entire car about 450 watts.

It was the intention when planning this lecture to secure a Pullman car and a day coach and install samples of the reflector in order

that the members of the Club might have the opportunity of each examining them for themselves and see the illumination thus provided. Unfortunately for our purpose, the congestion of travel at present is so great that we were unable to obtain the cars. We have therefore constructed this booth, to represent a single section in a car. The framework is made to the approximate dimensions of a cross section of a car. We intended to cover it with a lighter material, but when the material was received it turned out to be black. The discovery was made too late for correction. However, as we claim to be nearly independent of the color of the walls we expect that the illumination will show up good and strong. This booth was constructed by Mr. Stilwell who is here, and I would request that he place a few chairs in positions corresponding to car seats, and give the Club the opportunity of examing the illumination as provided, in order that they may see how adequately it covers the purpose. And then after that, if there are any questions to be asked or discussion we shall be very glad to furnish information on this or any other problem which we can, in connection with the car lighting.

I thank you, gentlemen. (Applause.)

President Seley: There will be a 10 or 15 minute recess for an examination of the exhibit by the members present before beginning discussion.

(After the recess:)

President Seley: We have had the benefit of a very interesting address as well as a very beautiful exhibit of car illumination. The remarks of Mr. Stickney are now open to discussion. Will Mr. Thompson start the discussion?

Mr. E. B. Thompson (A. S. M. P., C. & N. W. Ry.): It is certainly gratifying to know that the subject of car lighting is being taken up by engineers who are specialists in that line, and I am sure that it is gratifying and augurs well for the future of the car lighting to see the illustration we have had here to-night. I hope it is all that the inventors claim for it. I noticed an article in the newspaper a short time ago saying that gas lamps are being displaced and the public is clamoring that gas shall be taken away from the cars on account of the possibility of fire, the same as it clamored a number of years ago that the kerosense lamps be set aside.

President Seley: I have just realized to-night why it was I got so sleepy when I went to a certain church. It was on account of the row of lights along a side wall, one in front of the other, tending to spread my eyes apart and assume that abnormal position in my head. I think very likely that will account to some extent for the unpleasant feeling in some cars in which the lights are so placed as to bring the eyes to an unnatural position as stated by the speaker.

Mr. Stilwell: Mr. Chairman, there is a question that one of the members brought up in connection, especially with the shade. The question was what means were provided for lowering the shade. On this sample here I have attached the shade by means of a nut at the bottom, which would be a very inconvenient way for the average car cleaner to manipulate. Sometimes he will take the nuts off and sometimes he will skip the shade owing to the bother of taking off the nut. On our finished fixture we have a snap arrangement, similar to the snap catches which are now manufactured, so that it will be an easy operation to lower the shade; also after it is cleaned out it can be snapped up again. I have here the shade for the 3-light fixture. The inside surface is fairly smooth, so that a moistened cloth or sponge can be run over it and any dust or cinders which accumulate during the movement of the car can be readily removed. In some cars and under certain conditions it might be desired by the people installing the fixtures to have an individual shade, or at least approach an individual shade, and for that purpose we have developed an opalized shade that approaches the shape of the lamp, making it somewhat pear shaped, that curves gracefully around the lamps, giving an individual effect, so far as the lamps are concerned, to the fixture. For Pullman coaches I think the ornamental art glass fixture would lend itself pleasantly, not only so far as the light is concerned, but also as regards the ornamental fixture to the surroundings of the car.

President Seley: We shall be glad to hear from anyone in regard to this.

Mr. C. R. Gilman: Mr. Chairman, I would like to have Mr. Stickney tell us about the Tungsten lamp, about its durability, watts per candle, and whether it can be used in a horizontal position, so that we railroad people will better understand to what extent it can be used. We are very much interested and if the lamp is as economical as represented we would like to know more about it.

President Seley: Mr. Stickney will answer any of these questions in closing the discussion. I would be glad to hear from some of the acetylene gas people, if any are present.

Mr. R. C. Richards (C. & N. W. Ry.): Mr. Chairman, I would like to ask Mr. Stickney, if in this scheme of lighting cars any arrangement has been made to light the vestibules or platforms. While it is necessary to have the car lighted, so people can see when they are in the car, it is quite essential to have the platform lighted, so that passengers can get off without being hurt. We all know that many of our station platforms are insufficiently lighted, that passengers coming out of a brilliantly lighted car, go down the steps, and most claim agents know what happens. I am therefore very much interested in knowing whether anything is going to be done for the steps and the platforms.

President Seley: A very good point indeed.

Mr. Richards: If it is a proper question to ask, I would like to know what is the expense of this lighting as compared with our present system; is it greater or less?

President Seley: Mr. Stickney, I would suggest that we get all these points together and cover them in your closing. I am sure we are not at the bottom of it yet; we have not exhausted all of the inquisitiveness with regard to this system.

Mr. F. L. Baker: Mr. President, I would like to ask Mr. Stickney one question with regard to the use of opalescent lights, that is, the ground glass as against the clear glass. Do I understand from his statement that the hours of life of the lamp are less with the ground glass than they are with the clear glass, and if so, why? Referring to the use of electricity in lighting a car, I have a number of times been on the Pennsylvania railroad on one of the trains running between Pittsburg and Cleveland, in a car lighted by electricity, in which they use a clear light, and was, I presume, one of the first cars lighted by electricity, and I must say that about 50 per cent of the time that I was on the train I was unable to read a newspaper with any degree of comfort. The lighting that Mr. Stickney has shown to-night seems to be a very decided improvement over that. A few weeks ago I was riding on one of the roads leading eastward out of Chicago and previously to that time a young gentleman, a member of this Club, who was in the motive power department of that road, told me that they were using a new form of gas lamp, a sort of incandescent lamp, and employing a mantle. I was inclined to question that, because I know from my experiences in my own residence that those mantles are very delicate things, very hard to handle, won't stand any jar, and I could not understand how a pessenger coach, subjected to vibration as that is, could carry a mantle that could be used in connection with gas, but in traveling on this road I was fortunate enough to be in a car lighted with five groups of four lamps each, using the inverted gas fixture and mantles, and the lighting on that car seemed to me to be about as near perfection as anything in the gas line could be, because during that same trip I went into another car which was lighted with the ordinary lights, and the car seemed dark and dingy in comparison with it, but I see to-night that this use of electricity in the diffused form would appear to me to be superior even to that inverted incandescent gas system.

There is another point which Mr. Stickney brought out which I wish to refer to, and that is in regard to the mono-chromatic or single color scheme in lights, and if any of you gentlemen have any drawing rooms and you wish to illuminate those drawing rooms so your men can work overtime with comfort, I beg you not to put in a mercury vacuum light. I am a draftsman by profession and

where I am at present employed we use the mercury vacuum light. This gives a blue light. It is very similar to an incandescent light so far as the color of the glass goes, but if you have a red nose or a few red pimples on your face, no matter how clean you are during the day, at night it looks as though you had not had a bath for six weeks, red appears absolutely black, and while the light is diffused and it is possible to look at the light with the naked eye without blinding you, still the action of that light is to produce headaches and a number of the gentlemen present with whom I am personally acquainted and know to be draftsmen know that it is a very difficult thing to light a drawing board so you can work at night with any degree of comfort and without producing headache, and while this mercury vacuum light is a very nice light, so far as being diffused, and so far as doing away with shades and getting in your own light all the time is concerned, still the action of that single color, the elimination of all the balance of the colors of the rainbow has a tendency to produce what I consider a very bad physical effect on a person and it very soon tires a person out. So if you want to use a light in lighting your drawing rooms or your office so your men can work at night with comfort, and if you want to use a mercury vacuum light I would suggest that you use about as many incandescent lights as you can put in there to supply the yellow light that the mercury vacuum does not supply.

President Seley: Some very interesting points have been raised by this gentleman.

Dr. N. M. Black: Mr. Chairman, if it is not against the rules of the Club for an outsider to take part in the discussion I would like to make a few remarks. Being a novice as far as the lighting of cars is concerned, but having some little experience so far as eyes are concerned, I want particularly to emphasize the point brought out by Mr. Stickney relative to the intrinsic brilliancy of illumination affecting the eyes. The portion of the background of the eye which receives the light contains what is known as visual purple and the action of intense light from any luminous point on this visual purple, is to cause it to be used up producing rather discomforting after images. For instance, if you look at any one of these lights in the room for a few moments and then close the eye you will see for a moment or two an image of the filament very plainly. It is this intrinsic brilliancy which causes the tiring of the eyes, but if that light is properly diffused as it is with the apparatus exhibited the whole retina or the whole portion of the back of the eye receives the illumination equally and no brilliantly illuminated points or lines of light strike any portion and tire those parts more than others.

Another point brought out about the mono-chromatic light. The eye, since man came on earth, has been accustomed to daylight, and is accustomed more or less to the most prominent portion of

the solar spectrum, which is from the orange to the green, and any artificial illumination which nearly simulates daylight, if it has not too much intrinsic brilliancy or is properly diffused, will be the most restful to the eyes. That portion of the spectrum containing the yellow light is more nearly like daylight than any portion of the spectrum in the warm end of the actinic end, and I think the cause of the headaches and the tiring of the eyes with the Cooper-Hewitt light referred to is due to the effect of the actinic rays of the light, the blue and violet rays using up the chemical constituents of this visual purple of the eye. The reflection of the light from the drawing board being so intense it does not allow of regeneration of the visual purple and consequently tiring takes place.

Another point, in working in a drafting room with blue-prints there has to be a greater intensity of illumination in working upon such a surface than in working upon a white surface, because there is much more of the light absorbed. With a white surface, having an illumination of 2-foot candles, the eye is working with practically all the light that is necessary and any increasing in the intensity of illumination will not aid the vision to any great extent. This intensity may be reduced below 2-foot candles and not particularly affect the vision, because from 1-foot candle up the illumination working with black on a white background is comparatively sufficient, but in working upon blue-prints the illumination has to be from 5 to 10-foot candles in order to give sufficient illumination.

President Seley: Thank you, Doctor. Any further discussion? Mr. Stickney, will you be kind enough to answer some of these inquiries?

Mr. Stickney: I have made a note of the inquiries that have been made in regard to the apparatus. The first was in regard to the lighting of the steps and platforms of cars. In presenting this subject I took up especially the question of the general illumination of the body of the car, that being the particular problem covered by this one adaptation. We have not as yet outlined a particular adaptation for the conditions existing in the hallways and in the vestibules of cars. I see no particular difficulty in providing a sufficiently good illumination for such points. It would be desirable to use a dense diffusing shade so that the illumination which does not have far to travel will be fairly even over the small space.

In the question as to the expense of the system, I presume the gentleman referred to the amount of power consumed. I believe the present practice, if I remember rightly, requires from 1,500 watts upwards for an ordinary Pullman car. The scheme outlined here with the full light on would take about 1,000 watts, or 33 per cent less than the present practice. The illumination with half of the lights operating, I believe, was conceded by the gentlemen present to-night to be pleasanter than ordinary illumination with present practice, but we believe this higher intensity is desirable.

But even with all lights operating the amount of power required would be considerably reduced over the present practice.

One gentleman inquired regarding the shortening of the life of incandescent lamps by frosting the globe. In answer to that I would say this shortening of life is not due to the burning out of lamps, but to the method of estimating the useful life of an incandescent lamp. After the candle power of an incandescent lamp has fallen 20 per cent from the initial, it is ordinarily considered cheaper to throw it away and buy a new lamp, rather than to use them at the lower efficiency. The cause of the falling off in a carbon filament lamp is the cutting off of the light on the inside of the bulb, and as I said before, the theoretical reason has been worked out. It is covered by technical papers on the subject.

I am very well pleased with the discussion that the paper has brought out. In addressing you I understood that the majority of men were railway men rather than lighting men and I have tried to avoid technical details. What the discussion has brought out is very interesting indeed. I thank you, Gentlemen.

President Seley: The discussion, gentlemen, has been unusually short for so interesting a subject as this, and I had hoped that we should not have to close so early. The hour is yet early for the Western Railway Club. One of the gentlemen would like to have some information regarding the Tungsten Lamp.

Mr. Stickney: The great point of the Tungsten Lamp is its high efficiency as compared with ordinary incandescent lamps. This is due to the fact that it is possible to run Tungsten at a higher temperature than any other material which has yet been made commercial for the manufacture of filament. If carbon, for instance, will run at this temperature the carbon would evaporate off from the filament and in a short time the filament would burn out at some point and put the lamp out of service.

Tungsten which is a metal, has a lower resistence than carbon so that a longer and slenderer filament is required for the same voltage or circuit. In the samples which we have here there are two filaments connected in series each of which is about the size of an ordinary looped filament incandescent lamp for an 110 volt circuit. While these Tungsten lamps are intended for only 30 volts; another advantage of this lamp is that with a slight increase of voltage the temperature does not get up so rapidly as with the carbon lamp and hence it is not so liable to be burned out by variations in voltage. The explanation of the relation between temperature and efficiency of lamps may be interesting to you. When we heat a solid material, for instance, a lamp filament, up to a certain temperature no light rays are given off. As we increase this temperature, we come to a point at which a very dull red ray is emitted. Then the efficiency is very low. As we increase the temperature still further, the material becomes brighter and brighter, the color

becoming first yellow and then white. With the increasing temperature, the percentage of useful light rays increases very rapidly. In no incandescent lamp have we yet been able to produce pure white light without cutting down the life of the filament to such an extent that the cost of replacement becomes too great for ordinary commercial conditions. The Tungsten lamp, however, approaches more nearly to this ideal and at the same time shows a correspondingly high efficiency. In the electric arc, it has been possible to produce practically a white light, because carbon is maintained at the boiling point. As the eletrode used is comparatively cheap, it can be allowed to boil away and be replaced without excessive expense. The electric arc, however, is not adaptable in as small units as we desire to use for car lighting.

With regard to the shade furnished with the reflector, we are preparing to furnish, when desired, something similar to a ball globe. Personally, I have rather favored the trough-shaped, as in that shape less light is thrown lengthwise of the car and there is therefore less effect from the intrinsic brilliancy. There will undoubtedly be changes in the mechanical construction of the reflector when it comes to making them in large numbers, but the present design deems to be generally satisfactory. Several models have been made and examined by a number of railway officials in our laboratory at Lynn who have expressed considerable pleasure in the illuminating effects obtained.

Mr. Stilwell: There is a point I would like to add to that. Some gentleman remarked in regard to the finish on the steel work, that it appeared too much like a stamped ceiling. The higher raised points in the stamping, there would be touched off with gold leaf, so that in addition to adding to the appearance it would also relieve that absolutely flat steel ceiling effect which you get where there is just the white enamel as shown in the sample fixture.

President Seley: I have no doubt of the value of intelligent illuminating engineering as well as of other branches in improving the service of railroads. I have been personally very much interested and would be very glad to see it developed. Unless there is some further discussion a motion to adjourn will be in order. Before that is made, however, I would say that we hope at our next meeting to get back to the Auditorium. Principally on account of the crowded condition of both the Auditorium and the Stratford we were unable to get other accommodations for this evening. This, however, has been comfortable, and I think we have all been able to hear. Unless someone has something further to say a motion to adjourn will be in order.

Motion made, seconded and carried.

The David L. Barnes Library

SPECIAL NOTICE.

The David L. Barnes Library of this Club, at 390 Old Colony Bldg., Chicago, is open for the use of members and their friends, and we hope it will be used freely. It is open on week days from 9 a. m. to 5:30 p. m., except on Saturday, until 3 p. m. Books must not be removed from Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

Library, 390 Old Colony Bldg.

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The regular meeting of the Western Railway Club was held at the Auditorium on Tuesday evening, October 15, 1907. President C. A. Seley in the chair. The meeting was called to order by the President at 8 P. M. The following members registered:

Alexander, W.
Alsdorf, R. C.
Ault, C. B.
Barnes, C. B.
Bentley, H. T.
Callahan, J. P.
Crawford, J. G.
Dangel, W. H.
Derby, W. A.
Ensign, H. W.
Fitzmorris, Jas.
Fogg, J. W.
Forsyth, Wm.
Frechette, C. J.
Gardner, J. E.
Goodnow, T. H.
Goodwin, G. S.
Graves, F. W.
Haynes, J. R.
Hill, G. H.
Hinds, J. B. L.
Hopkins, Geo. H.
Hunter, Percival
Jeffries, B. H.
Jenks, C. D.
Johnson, A. B.
Keeler, B. A.
Kelley, H. D.
Kilpatrick, J. B.
King, C. H.
Kucher, T. N.
Lambert, M. B.
Lancaster, J. R.
Langan, J. N.
La Rue, H.
Lickey, T. G.
Little, J. C.
Lowder, R. S.
McAlpine, A. R.
MacKenzie, D. R.
Manchester, A. E.
Markham, J. T.
Meeder, W. R.
Miller, H. B.
Naylor, N. C.
Parish, Le G.
Prentiss, G. N.
Riddell, Chas.
Seley, C. A.
Sharp, W. E.
Shumate, Frank D.
Smith, H. E.
Smith, W. R.
State, R. E.
Stow, H. J.
Stubb, F. W.
Sweringen, Geo.
Switzer, E. M.
Taft, R. C.
Tawse, W. G.
Taylor, J. W.
Thompson, E. B.
Thurnauer, Gustav
Towner, M. E.
Towsley, C. A.
Vauclain, S. M.
Wallace, W. G.
Wallerstedt, H.
Warner, H. E.
Woods, E. S.
Yereance, W. B.
Younglove, J. C.
Zealand, T. H.

PRESIDENT SELEY: The meeting will please come to order. The first business will be the approval of the minutes of last meeting. These have been printed and distributed and unless there are any errors to be corrected, they will stand approved as issued.

Next in order will be the report of the Secretary.

THE SECRETARY: Mr. President, I have the usual membership statement:

MEMBERSHIP STATEMENT.

Membership, September, 1907		1414
Resigned	5	
Dropped—Non-payment of dues	12	17
		1397
New members approved by Board of Directors		25
		1422

NEW MEMBERS.

Name, Title and Address	Proposed by
E. H. Ward, Secy & Treas. Memphis Car Co., Memphis, Tenn.	R. B. Kadish
W. A. Simms, Genl. Supt. Memphis Car Co., Memphis, Tenn.	R. B. Kadish
W. H. Heckman, Special Inspector, C. B. & Q. Ry., Chicago, Ill.	C. B. Young
C. L. Woodruff, Tousey Varnish Co., Chicago, Ill.	A. E. Goodhue
F. W. Hahn, Rodger Ballast Car Co., Chicago, Ill.	Swen Holmes
R. S. Faragher, Secy. & Treas. Blue Island Car & Equipment Co., Chicago, Ill.	J. W. Taylor
F. W. Marquis, Instructor, Ry. Eng. Dept. U. of I., Urbana, Ill.	E. C. Schmidt
F. W. Graves, Scullin-Gallagher Iron & Steel Co., Chicago, Ill.	A. B. Johnson
L. W. Sawyer, New York Air Brake Co., Chicago, Ill.	H. E. Tucker
W. L. Ehrich, Supt. Bonanza Belt Copper Co., Johnson, Ariz.	J. W. Taylor
S. G. Down, Westinghouse Air Brake Co., Chicago, Ill.	C. C. Farmer
R. B. Fulks, Water Inspector, C. B. & O. Ry., Aurora, Ill.	G. H. Hill
G. C. Denny, Mch. Asst. Laboratory, C. B. & O. Ry, Aurora, Ill.	G. H. Hill
C. L. Ransom, Res. Engr. C. & N. W. Ry., Omaha, Neb.	A. K. Shurtleff
H. H. Scovil, Railway Steel Spring Co., Chicago, Ill.	N. C. Naylor
H. E. Davis, Engr. C. M. & St. P. Ry., Ladd, Ill.	L. M. Addleman
E. H. O'Neil, Asst. to Genl. Supt. M. & N. E. R. R., Manistee, Mich.	W. H. Nuttall
Wm. Fair, Gen'l Foreman C. B. & Q. Ry. Shops, Hannibal, Mo.	J. W. Cyr
J. M. McCarthy, C. C. to Gen'l Pur. Agt., Rock Island & Frisco Road, Chicago, Ill.	C. A. Seley
Richard Gear, Armour Car Lines, Chicago, Ill.	W. E. Sharp
J. S. Lauby, Shop Instructor L. S. & M. S. Ry., Elkhart, Ind.	C. A. Towsley
F. C. Fosdick, A. M. M., C. & N. W. Ry., Chicago, Ill.	W. R. Smith
W. T. Gale, Foreman C. & N. W. Ry., Chicago, Ill.	W. R. Smith
F. J. O'Rourke, G. F., C. I. & S. R. R., Gibson, Mo.	J. T. Flavin
H. L. Osman, S. C. D., Morris & Co., Chicago, Ill.	M. M. Vincent

RESIGNATIONS.

M. E. Wallace, Westinghouse Air Brake Co., Hamilton, Ont., Can.
W. W. Ricker, Guarantee Construction Co., New York.
Mehrle Middleton, Standard Steel Works, Chicago.
Burton R. Stare, Peckham Mfg. Co., Chicago.
Thos. T. Doran, C. B. & Q. Ry., Burlington, Ia.

DROPPED—NON-PAYMENT OF DUES.

F. H. G. Albrecht, Asst. Foreman, C. & E. I. R. R., Chicago.
G. M. Bean, A. T. & S. F. Ry., Chicago.
H A. Brimley, M. P. Dept. Penna.. Ft. Wayne, Ind.
G. T. Briggs, Quincy, Manchester-Sargent Co., Chicago.
C. P. Burgman, Chgo. Ind. & Louisville, Hammond, Ind.
R. T. Farrell, Ill. Southern Ry., Sparta, Ill.
Wm. Grady, Trav. Engr. E. T. & E. R. R., Joliet, Ill.
J. A. Hill, Los Angeles, Cal.
A. T. Herr, Amer. B. S. & F. Co., Denver, Colo.
K. D. Hequenbourg, Franklin Ry. Supply Co., Franklin, Pa.
C. W. Kelley, Supt. B. & B., C. & N. W. Ry., Boone, Ia.
O. C. Mann, Young-Mann-Averill Co., Chicago.

THE SECRETARY: Mr. President, I would like to give notice at this time that for the November meeting we will have a paper entitled "Fuel Cost as Affected by Heat Value and Distribution," by Mr. J. G. Crawford, Fuel Engineer of the Burlington Road. Those are all the announcements I have to make, Mr. President.

PRESIDENT SELEY: The next and principal business of the evening will be consideration of the paper on "Steel Tires—Causes of Defects and Failures," by Mr. George L. Norris, Mechanical Engineer, Standard Steel Works. Gentlemen. I take great pleasure in introducing Mr. Norris.

STEEL TIRES—CAUSES OF DEFECTS AND FAILURES.

MR. GEORGE L. NORRIS, M. E. STANDARD STEEL WORKS.

With few exceptions the tires used in the United States are all made from (acid) Open Hearth Steel, its uniformity in quality and cheapness, as compared to crucible steel, having practically driven the latter out of the market. In Europe, whilst most tires are made by the Open Hearth process, and some by the crucible process, tires of (basic) Bessemer steel are also commonly used. The conditions of service, especially as to wheel loads, are not however, as severe as in America.

The grade of steel used for tires in Europe is much softer than that used in America, as shown by some of the typical analyses in the following table.

	American	*French*	*English*	*English Export*	*German*	*Krupp Export*
Carbon	55- 75	.40	36	52- 61	35	55- 85
Silicon	250	100	080	190	150	300
Phosphorous	050	050	055	030	095	060
Manganese	65	66	1 25	75	38	60
Sulphur	050	065	050	030	040	045
Ultimate Tensile Strength	100,000 to 135,000	95,000	85,000	107,000 to 123,200	90,000	105,000 to 135,000
	2″	(8″)	2″	2″	2″	2″
Elong.	20% to 10%	12%	26%	17%-14%	28%	17%-8%
Reduc.	30% to 12%		39%	23%-18%	38%	25%-9%

Up to 1890 it was the general practice to make tires from short ingots, each ingot being sufficient to make only one tire. As it is practically impossible to cast an ingot of steel no matter how small, without pipe and segregation in the upper end, tires made from the short or single tire ingot are liable to contain defects from this cause. In manufacturing from a short ingot no cropping is discarded from the top of the ingot, the only discard being the small disc of metal punched from the center of the bloom.

About the year 1890 the Standard Steel Works conducted a series of tests comparing the tires manufactured from short or single tire ingots, and long ingots from which several tires could be cut, and the top portion of the ingot containing the piping and segregation discarded . A paper on the results of these tests was contributed to the American Institute of Mining Engineers, by Mr. A. A. Stevenson, M. E. As a result of these investigations the Standard Steel Works adopted the practice of making all their tires from bottom-poured

long ingots, as the only way to reduce to a minimum the number of tires failing in service on account of casting defects in the ingot.

Both the long and short ingots are usually bottom cast in groups, fed from a central runner. The long ingots are octagonal in section, about seventy-two inches long, and vary from thirteen to twenty inches across. The short ingots are usually cylindrical, though conical ingots are common abroad, and have generally a dome shape top. They vary in diameter and height according to the size of tire to be made. Unlike the long ingot which remains fluid for some time and gives an opportunity for the steel to teem, and the gases and impurities to rise to the top, the short ingot sets quickly and the piping, gas cavities and other defects as compared with the long ingot, occupy relatively a larger portion.

Even with the minimum amount of piping possible, the punching does not always entirely remove the defects and consequently the tires made from short ingots more frequently contain these defects. The illustrations Figures 1 to 9 plainly show the superiority of the long ingot over the short for manufacturing tires of homogeneous

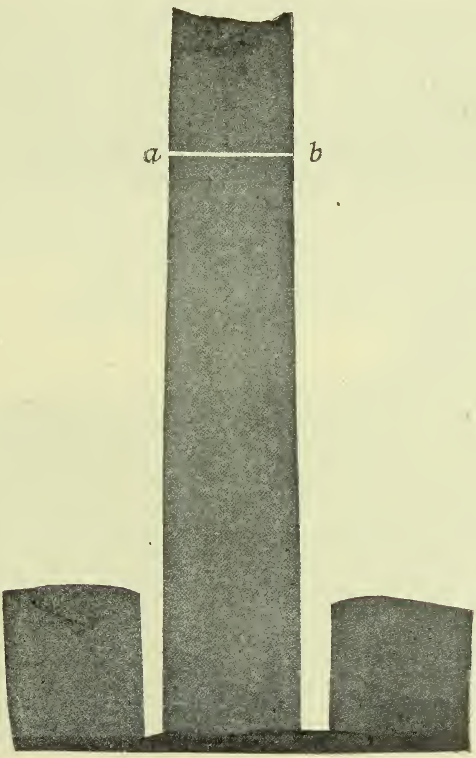
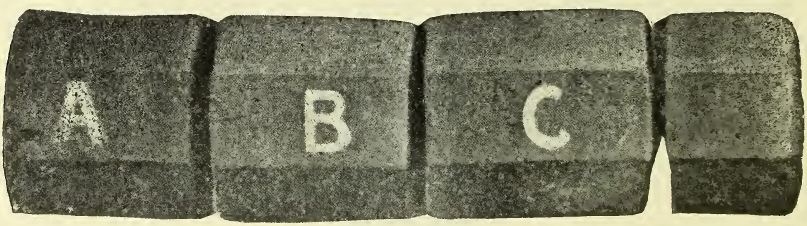


Fig. 2 Fig. 1 Fig. 3

structure. Figure 1 is a full length section of a long ingot from which the piped portion above the line *a-b* is discarded, while Figure 2 is a section of the ordinary short or single tire ingot from which nothing is discarded but a small thin disc in punching the bloom. Figure 3 is a section of a tire bloom from a long ingot. The contrast between it and the short ingot is very marked. Figure 4 shows the manner of cutting an ingot into tire blooms. Figure 5 is an etched section of a tire made from a long ingot bloom, and shows the homogeneity of structure obtained by this method of manufacture. Figures 6, 7 and 8 show etched sections of tires made from short ingots, illustrating the presence of the original casting defects. Figure 9 is a section through a conical ingot such as is used to some extent in Europe. For soundness this possesses no advantage over the ordinary cylindrical, short ingot.

SHELLY TIRES.

During the past few years owing to increased speeds, wheel loads and severity of service, steel tires have more frequently developed



TIRE. TIRE TIRE DISCARD

Fig. 4

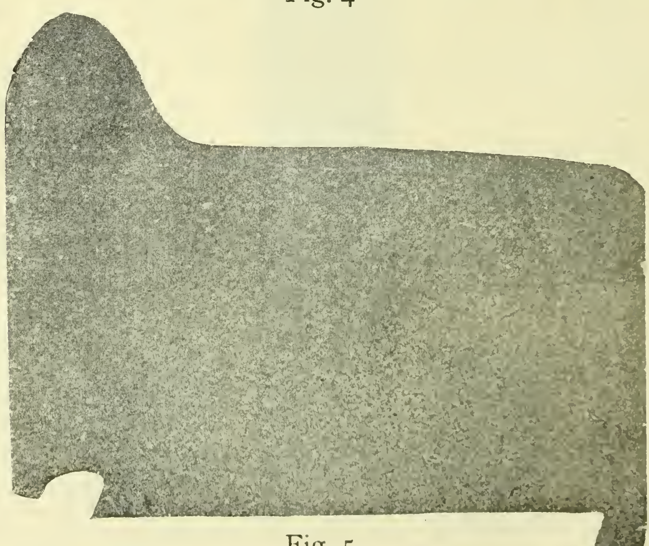


Fig. 5

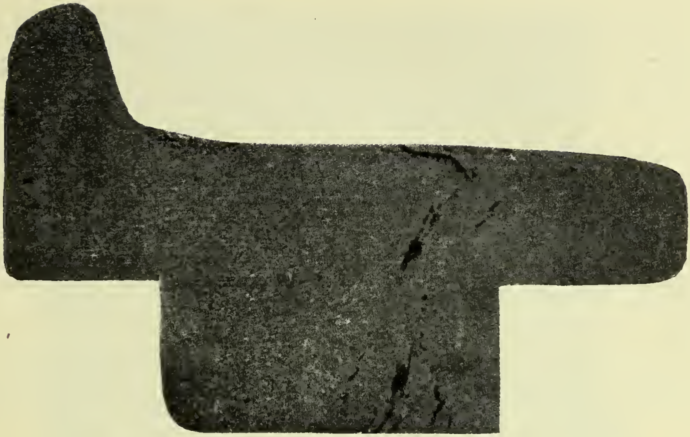


Fig. 6

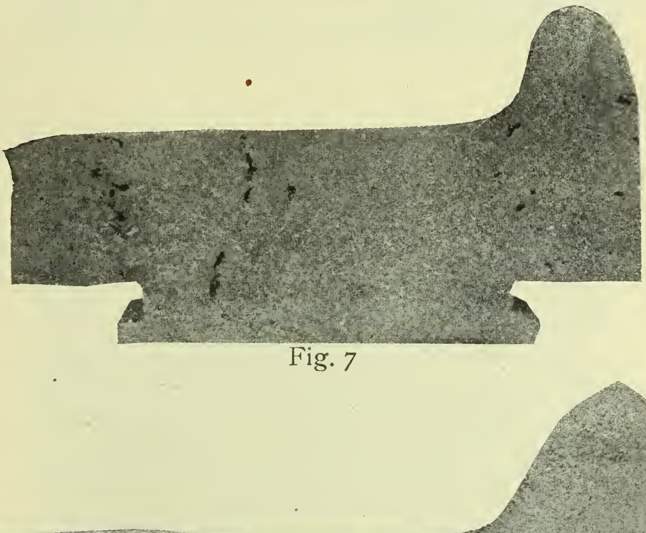


Fig. 7

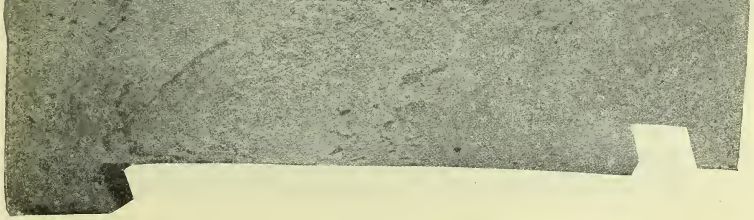


Fig. 8

that condition on the tread, commonly termed shelly or flaky spots. This condition is also often referred to as "soft spots," "porous," or "honey-combed metal," "sand holes," and "unwelded metal." It is in the nature of a breaking down of the tread into flakes or scales, by numerous cracks which penetrate into the tire, principally in the area of rail contact. A tire developing such a condition is not considered dangerous, and consequently is not always promptly removed. Hence the shells or flakes rapidly spread over a greater length of the tread, and the cracks have penetrated so deeply into the tire that a large amount of steel is wasted in turning up the tire to remove all traces of the shelliness. Figure 10 shows the appearance of the tread of a typical shelly tire.

The causes which produce this condition of shelly or flaky treads may be inherent defects in the steel, such as pipe, gas cavities, slag and segregation, but are more commonly the conditions of service.

PRODUCED BY INHERENT DEFECTS IN THE STEEL

These are confined almost exclusively to tires made from short ingots and rarely occur in tires from long ingots, for the reason that the top portion of the ingot containing the pipe, slag, segregation and gas cavities, is discarded. The connection between the piping and casting defects of the ingot and the shelliness of the tire is plainly shown in Figure 6. Usually the appearance of the tread of a shelly

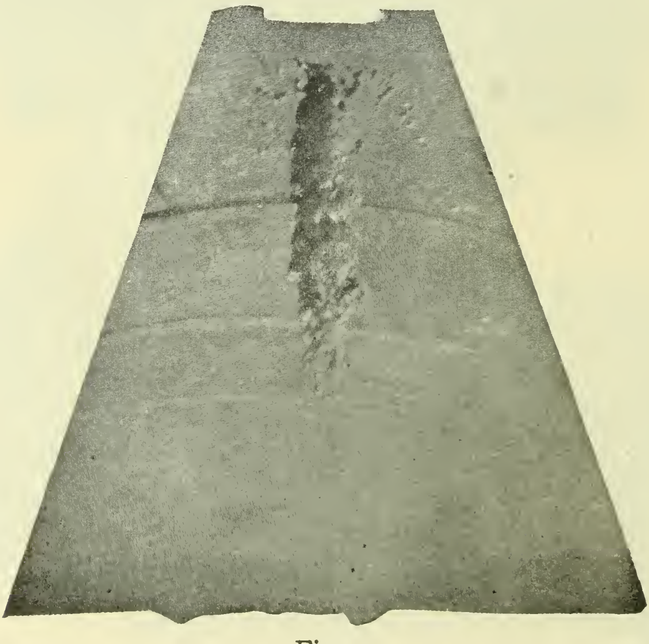


Fig. 9

Fig. 10

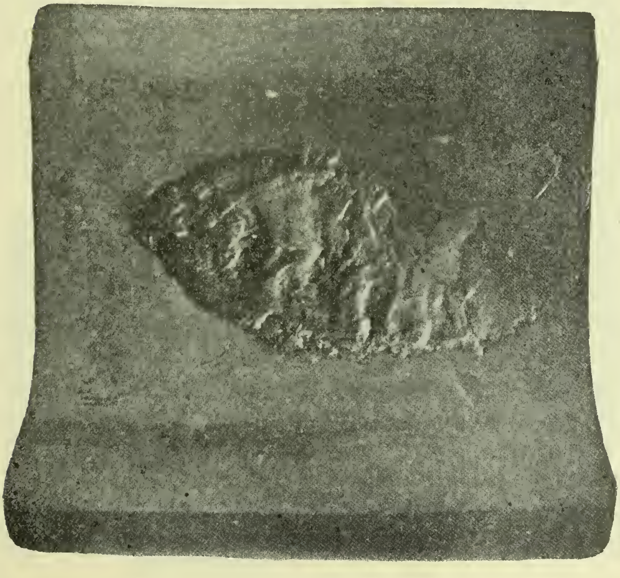


Fig. 11

tire from inherent defects in the steel is different from the ordinary shelliness due to service conditions. Instead of the tread showing spots with numerous thin flakes, as in Figure 10, there is apt to be only a single spot from which a large shallow piece has spalled out, (see Figure 11), or there may be several spots where pieces have broken out of the tread leaving distinctly granular fractures, as in Figure 12. An etched transverse section of this tire, (see Figure 13), shows that these defects are due to entrapped slag.

PRODUCED BY CONDITIONS OF SERVICE.

As has been stated, by far the greater number of shelly tires are produced by conditions of service, and in the case of tires from long ingots this is practically the sole cause of this trouble. The conditions of service most prominent in causing shelliness are: Brake burns; eccentricity of the wheel, causing pounding and slipping, and unequal diameters of wheels upon the same axle, which may result in causing the wheel to become eccentric through slipping. These conditions are all intensified by speed and load, but more especially by speed. It is probable that what is commonly termed "brake burn" is the chief cause producing shelliness. When the brake shoe retards the revolution of the wheel to the extent that the distance traversed by the car exceeds that rolled by the wheel, a high degree of heat is generated locally on the tread, due to the slipping of the wheel on the rail. This results in the production of several small, hard slip spots, or brake burns on the tread within the limits of the rail contact. These small hard spots are usually covered with irregular heat cracks, which through the pounding of the wheel on the rail and joints, and under the influence of various stresses to which the tires are subjected, tend to penetrate into the tire along the line of the resultant forces, causing the steel to break up into shells or flakes. In the case of chilled wheels the brake burns produce what is termed comby tread, and the penetration of the cracks is along the cleavage

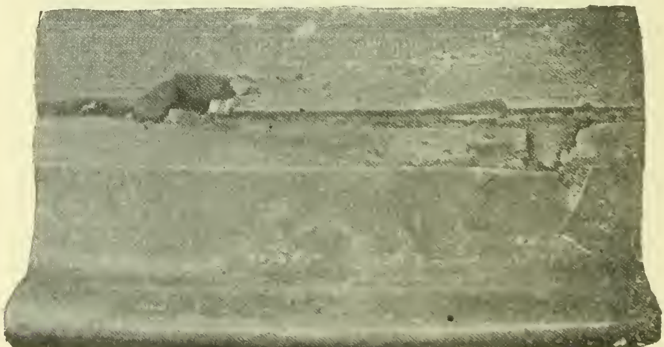


Fig. 12

planes of the white iron crystals forming the chill, and perpendicular to the tread.

Many of the hard slip spots developed disappear through the friction of the tire on the rail, or under the scouring or tooling effect of the brake shoe, without breaking up into shelly or flaky spots. In those cases eccentricity of the wheel results, and long, rolling flats are produced, sometimes 30 to 40 inches in length and as much as ½" deep at the lowest point. Frequently such wheels will have two rolling flat spots. The severe punishment through pounding and slipping which eccentric wheels undergo, produces very excessive and deep shelling. That the wheels become eccentric or out of round through the hard, slip spots has often been tested, by putting a pair of wheels showing such spots, but not shelled, into the lathe. It is not infrequent to find that the tool will skip for a space of two or three feet while cutting to a depth of 1/16 inch.

It is conspicuous that some of the roads having the greatest amount of trouble from shelly tread tires, find the trouble most serious on low grade divisions with infrequent brake applications, and on the heavy grade or mountainous divisions of these same roads the trouble is only slightly developed. This indicates that the long continued brake application on the heavy grades is effective in grinding off the small hard spots, or in other words the tread is worn down faster than the rate of penetration of the heat cracks in the burned or slip spot area.

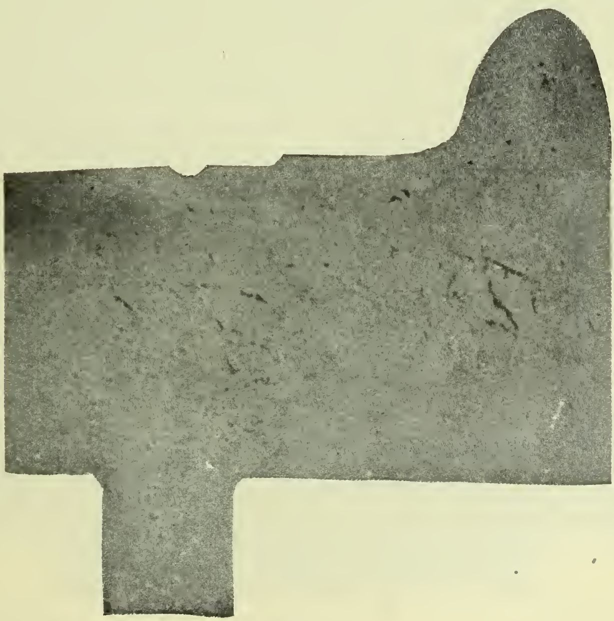


Fig. 13

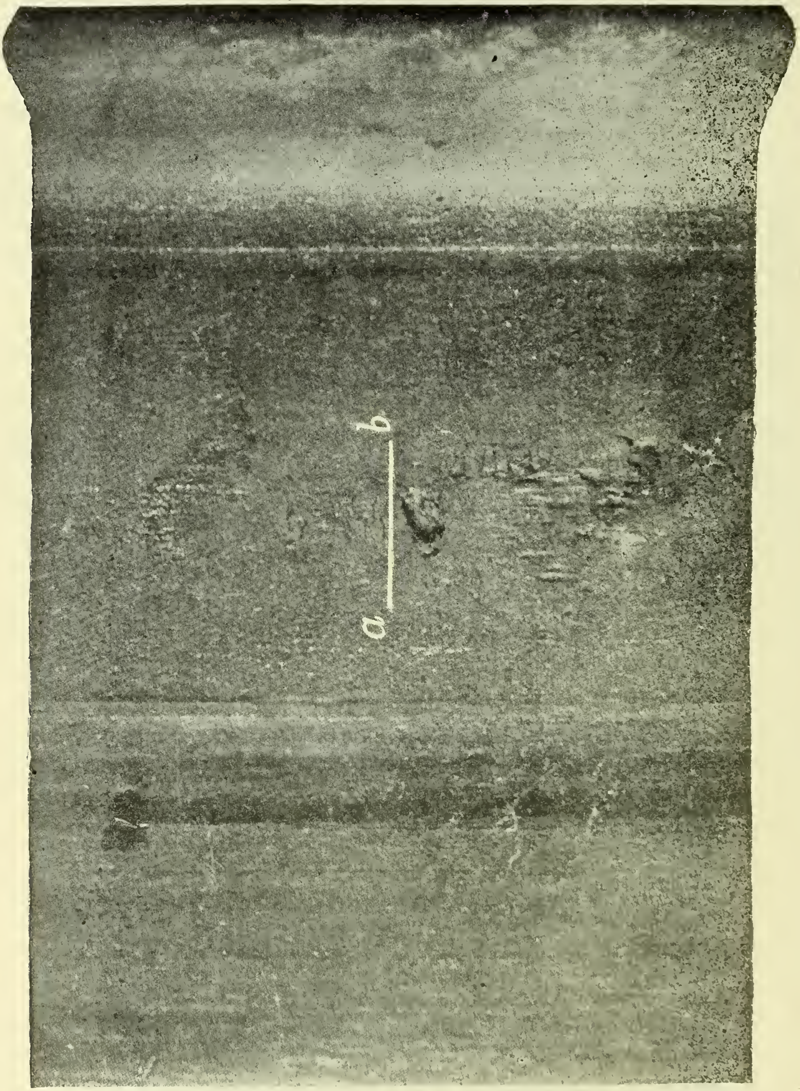


Fig. 14

The formation of the shelliness from the hard, slip spots, or brake burned areas is very well shown by the illustrations. Figure 14 is a view of a tire showing several of the brake burn spots, one of which has started to form a shelly spot. Figure 15 is a section through this spot on line *a-b* polished and magnified two diameters. The white area *a-b* is very hard and might be likened to a case hardened spot. Figure 16 is a section through another spot on the same tire, polished and slightly etched to emphasize the contrast. It is the breaking up of these hard areas that originates the detailed cracks which penetrate into the tire and cause shelliness. Figure 17 is an etched section of a shelly tire, and shows no inherent defects. Figure 18 is a view of the tread of the same tire which shows an advanced stage of shelliness. Figure 19 is a section cut from the tire as indicated on Figure 17, and polished and magnified forty diameters. It corresponds to the hard area shown on Figure

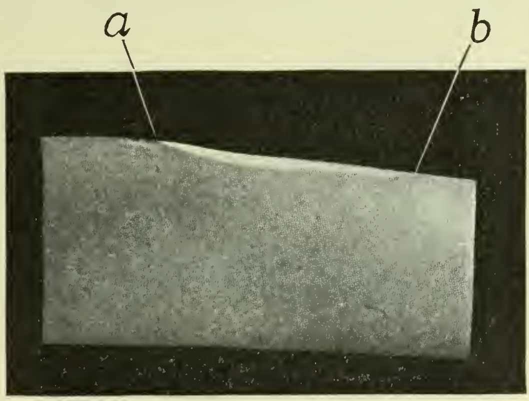


Fig. 15

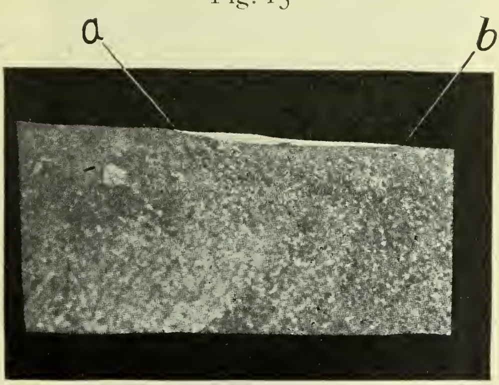


Fig. 16

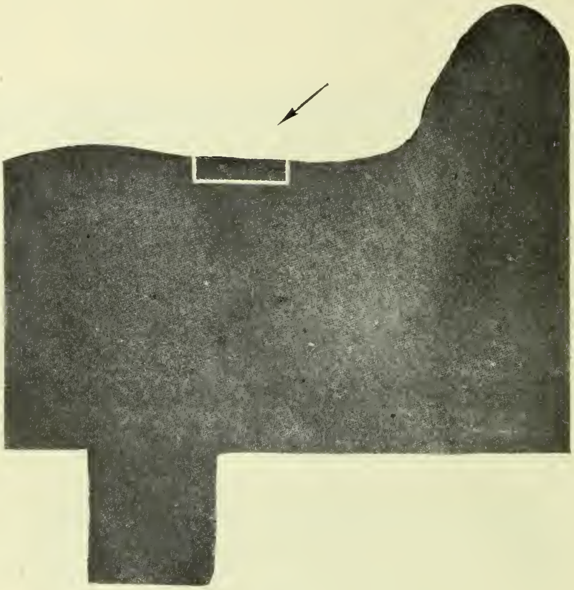


Fig. 17

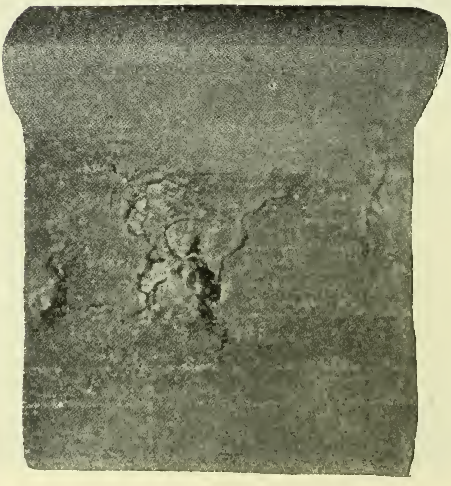


Fig. 18

15, the letters *a-b* on Figure 19 marking the limit of depth of the hard spot. The mental between *a-b* and the tread shows a bodly cracked condition, and it is through the penetration and extension of these cracks that shelliness is caused and spreads as long as the tire remains in service after this condition originates. Figures 20 and 21 are etched sections to show the microstructure of Figure 19, magnified fifty diameters. In both Figures 20 and 21, the line *a-b* corresponds to *a-b* in Figure 19. In the case of Figure 20, which is located outside the cracked or shattered area, cleavage has not taken place along this line as is the case in Figure 21. The microstructure of the mental between the line *a-b* and the tread is distorted, but there is no tendency indicated towards separation of the micrograins along the lines of ferrite. This would be the case if the cause of shelliness was commonly due to microscopical particles or

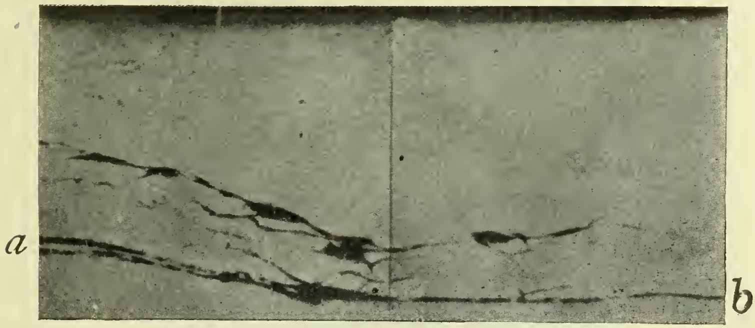


Fig. 19

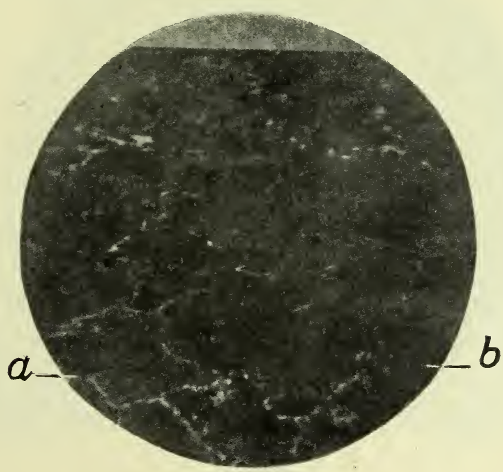


Fig. 20

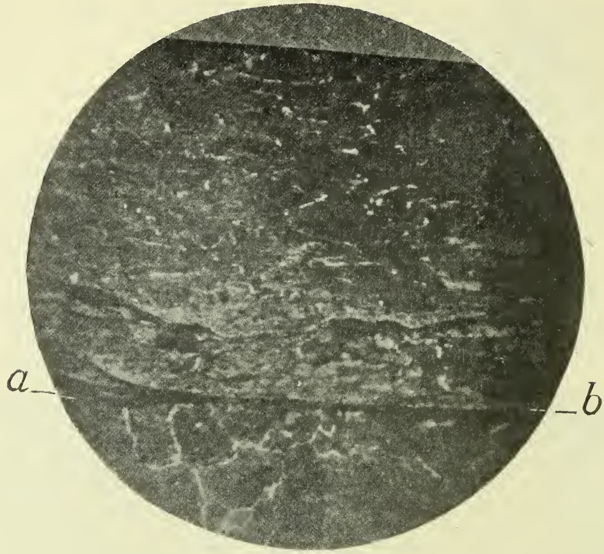


Fig. 21

Fig. 22

filaments of entrapped slag, as these usually occur in the ferrite. The microstructure below the line *a-b* is entirely unaltered and the line of demarkation is wonderfully sharp, cutting as it often does through the micrograins, and separating them into distorted and undistorted portions. Figures 22 and 23 illustrate clearly how these cracks extend and multiply. Figure 22 is a polished, but unetched specimen from a tire in the initial stages of shelling, magnified thirty-five diameters. Figure 23 is a portion of the same specimen, etched and magnified fifty diameters. There is no evidence of any inherent defects. Figure 24 is a longitudinal section of a shelly tire and gives a good idea of the manner in which the shell cracks penetrate into and break up the steel. Neither this section nor the transverse section, Figure 25, shows any inherent defects.

Fig. 23

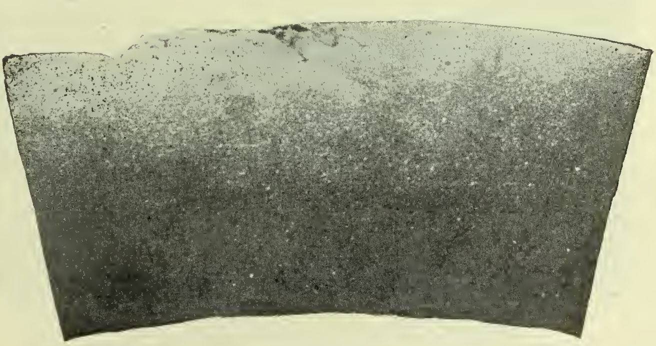


Fig. 24

It is notable that driving tires are practically free from shelling, which certainly would not be the case if the shelliness was largely the result of inherent defects in the steel, improper treatment during manufacture, or defects of workmanship. The few cases of driving tires which have been examined were due to inherent defects in the steel. Brake burns and slip spots are apparent on the tread of driving tires, but the rate of penetration of the cracks, owing to their greater diameter, and flatness of arc, is slow, and consequently their removal by brake wear is quite certain. Furthermore, the service conditions of driving tires are less severe than those of the tender, trailer, and coach wheels. The number of revolutions is less, the area presented to the rail is greater, and the brake application is more effective. The static wheel load for driving wheels of modern high-class passenger locomotives averages about 22,000 pounds per wheel, while in the case of many trailing wheels and wheels under large capacity tenders the wheel load is as great and is carried on a smaller area of rail surface.

The liability to shell is far greater in the case of tender wheels under heavy tanks in through passenger service than any other class of equipment. The service conditions of the tender wheels are the hardest of all the wheels, owing to the constantly shifting and varying load carried. The varying load not only effects the percentage of brake application, giving a variation in the retarding effect of the brake shoe on the wheels, and increases the liability to brake burn spots, but also causes the tender to ride rough and to pound the wheels. This is on account of the stiffness of the springs, which are designed for full load, but carry a light load much of the time in service. There is a marked increase in the number of shelly tires

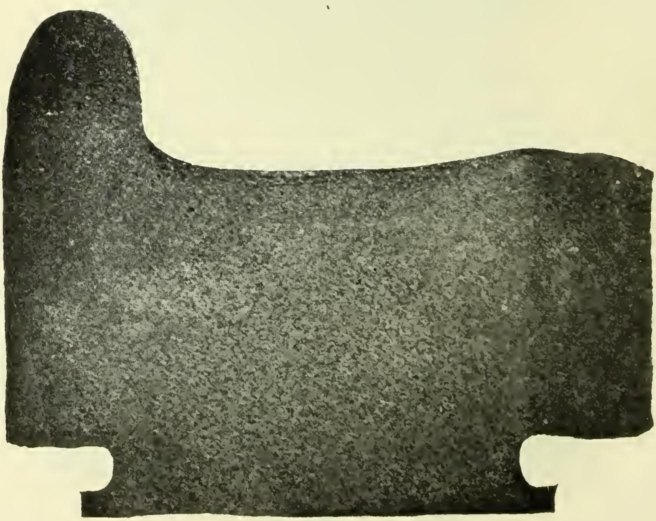


Fig. 25

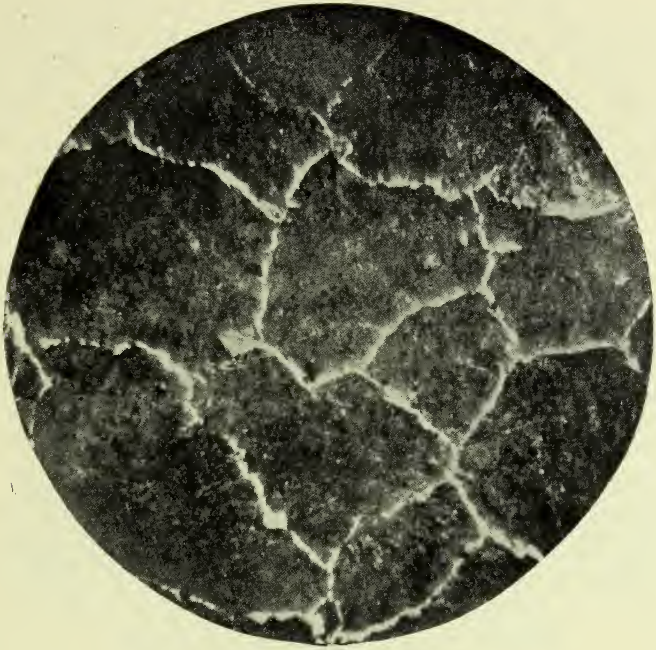


Fig. 26

Fig. 27

during the winter season, which is natural, as all conditions of operation are more severe. In general the wheels under tenders do not receive the same attention as wheels under coaches. The inspection may be close, but it has been observed that those roads having the most trouble from shelly wheels keep tender wheels in service that they would not tolerate under coaches. This observation is confirmed by the records of the wheel lathes which show an average of about twice as much metal turned off the tender wheels as from the coach wheels.

Trailer wheels probably rank next to tender wheels in tendency to develop shelliness. Most of the cases of shelly trailer wheels observed have been under engines in through passenger service, and the wheel load has averaged 20,000 pounds and upward per wheel. This great load, with the tendency of the trailer wheels to "pick up" on the application of the brakes and develop brake burn spots is doubtless the reason why they have given so much trouble from shelliness.

Coach and engine truck wheels come next in order. Most of the shelly coach wheels have been under heavy cars in through passenger service. The majority of cases have been distinctly traceable to brake burns.

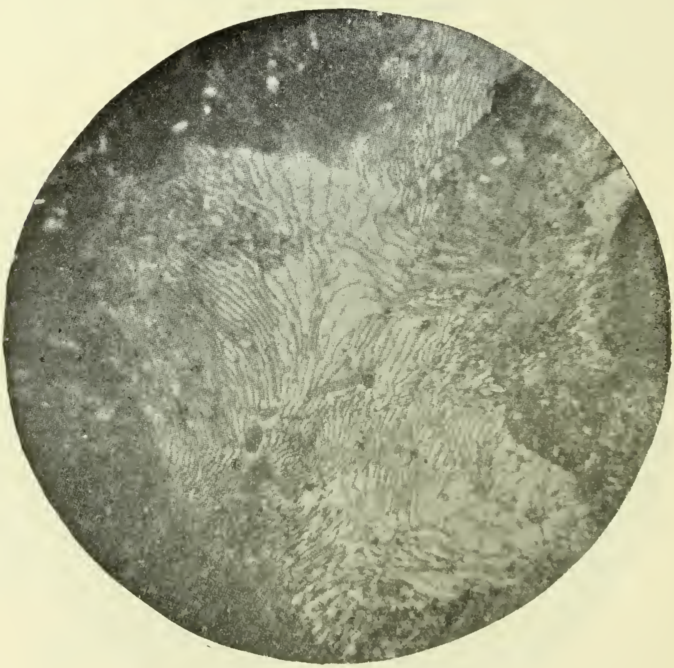


Fig. 28

CONSIDERATION OF HEAT TREATMENT AND MICROSTRUCTURE

The heat treatment of any piece of steel as evidenced by the microstructure, is important. Upon the proper heat treatment depends, first, the ability to produce the article, and second the quality of the article. The phrase "improper heat treatment," however, has of recent years been much abused to explain "mysterious" failures. In the manufacture of tires it is practically impossible to make a tire from an overheated or underheated ingot, as such an ingot would not withstand blooming under the hammer without failure.

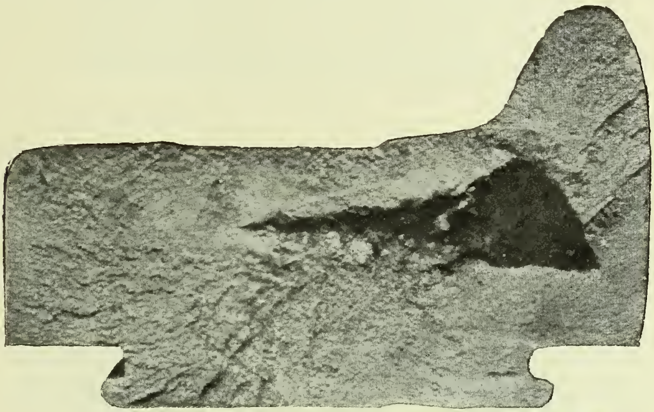


Fig. 29

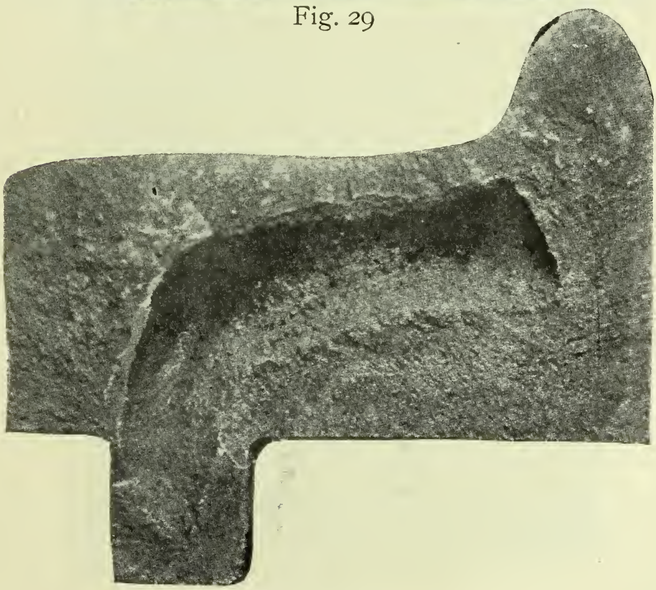


Fig. 30

The examination of the microstructure of hundreds of discarded tires which have given good service shows what would usually be considered large grain structure. The natural micrograin of steels of the carbon percentage used for tires is quite large. To obtain a fine microstructure it is necessary to anneal the tires. This treatment however, has no effect in preventing shelliness. It is conceivable that under the heaviest wheel loads the annealed tire with the fine microstructure and large amount of isolated ferrite, or pure iron, would not give mileage results equal to the unannealed tire from the same steel, with its larger area of pearlite and greater resistance to distortion under compression. In the case of the comparatively large, natural grain of the tire as rolled, a greater area of pearlite is presented for wear than in the case of the annealed steel, as is shown in the illustrations, Figures 26 and 27. Pearlite is the eutectic or saturated steel. It is composed of an intimate mixture of cementite (carbide of iron) and ferrite, (pure iron) usually in a lamellar structure, Figure 28. An ideal steel would be one whose structure is entirely made up of pearlite. Such a steel would contain about .85 per cent. carbon, and would be too hard for most conditions of service.

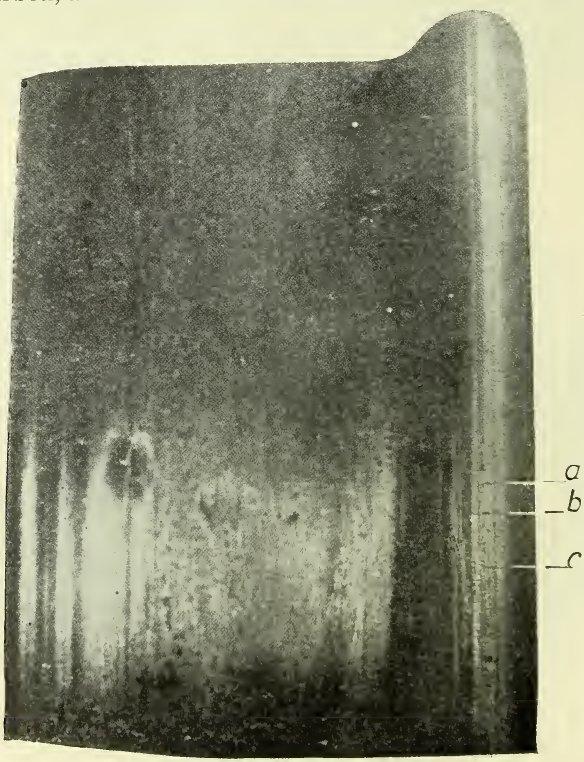


Fig. 31

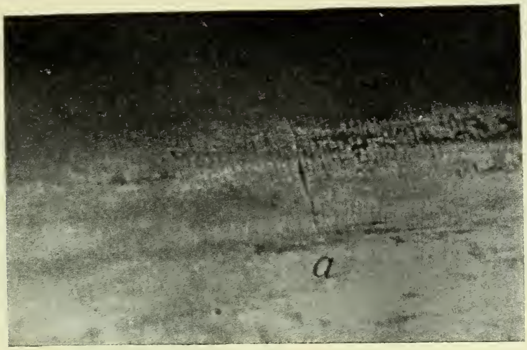


Fig. 32

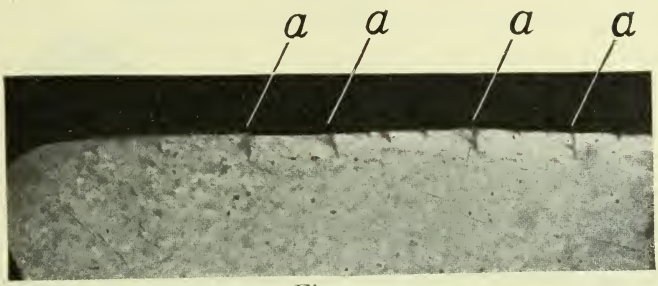


Fig. 33

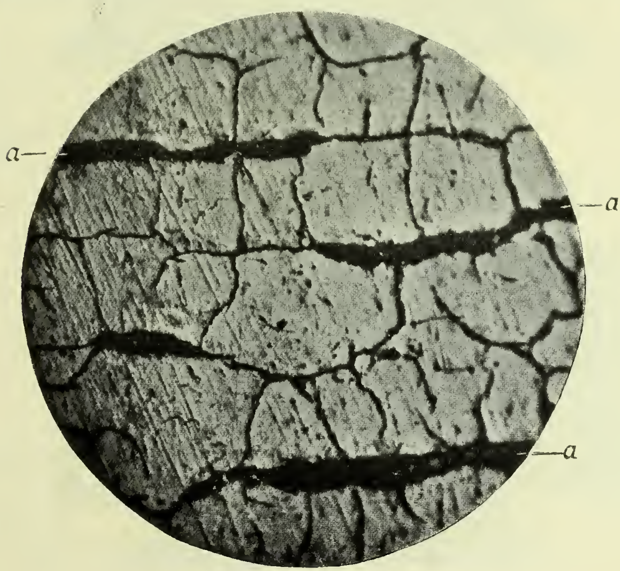


Fig. 34

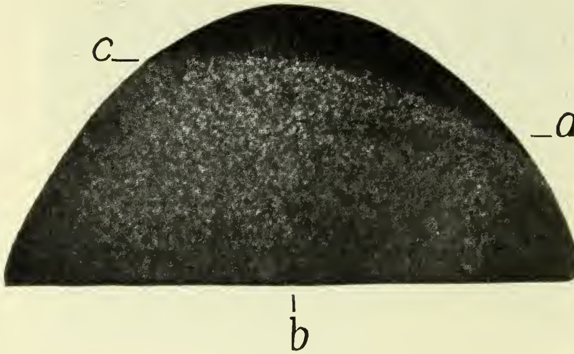


Fig. 35

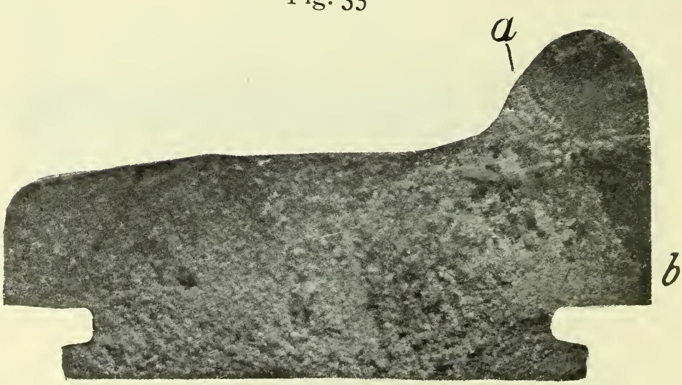


Fig. 36

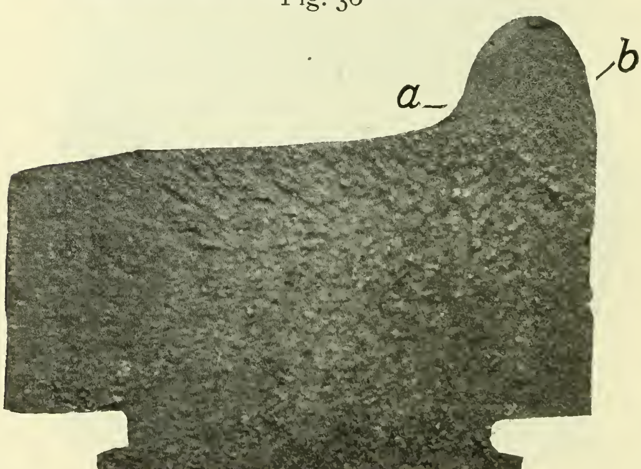


Fig. 27

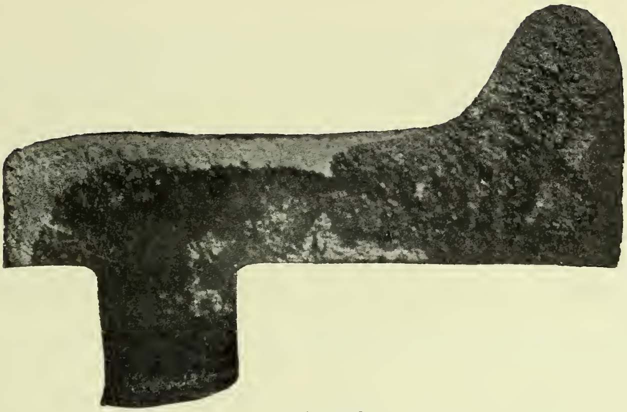


Fig. 38

The macro or visible structure, rather than the microstructure, plays the most important part in the life of the tire. Unlike rails, and blooms, it is not possible to roll tires direct from the initial casting heat of the ingot, consequently the ingot solidifies undisturbed by work under the hammers or in the rolling mill, and practically never shows the pronounced porosity so common in the center of the rail head. Working from a cold ingot which has solidified undisturbed, the maximum effect of the work under the hammer and in the rolls is obtained, increasing the density and homogeneity of the macro or visibe structure.

BROKEN TIRES

The causes producing failures of this sort are: excessive shrinkage, inherent defects in the steel, transverse fracture of the flange, and loose tires.

EXCESSIVE SHRINKAGE

Failures from this cause take place soon after application of the tire to the center, and always before the tire has had any appreciable service. After the tire has been in service a short time molecular readjustment has been completed in the form of motional annealing. This increases the ductility of the steel, as shown by increased elongation and reduction of area of comparative test pieces from tires from the same ingot before and after service.

INHERENT DEFECTS IN STEEL

These defects are usually due to piping. In some cases the pipe is present as a cavity, (Figures 29 and 30) which causes the tire to burst with sharp transverse fracture. In other cases the pipe is present as in Figure 7,and then a piece of flange or tread is broken off. Tire failures from these defects are practically eliminated by the method of manufacture from long ingots.

TRANSVERSE FRACTURES OF THE FLANGES

This is a detailed fracture originating on the point of the flange from heat cracks produced by the action of the overlapping brake shoe. Most of the failures of this kind have been tender and coach wheels in service over long heavy grades where the brake application is especially severe. It has been observed that wheels which have so failed are generally equipped with brake shoes without inserts. Such brake shoes generate much more heat on the flange than those with inserts, and are not so effective in scouring off the heat cracks formed by long continued brake application. In the case of the brake shoe with inserts in the flange groove, there is quite an effectual cutting or scouring out of the heat cracks and they are therefore less liable to start a fracture.

The illustrations 31 to 37 show plainly the origin of the flange fracture from the heat cracks, and its development into a full fracture of the tire. Figure 31 is a view of a tire showing several small flange fractures, *a-b-c,* and their relation to the heat cracks on either side is obvious. Figure 32 shows a portion of a flange, full size, showing more clearly than Figure 31 the heat cracks with a fully developed fracture (*a*) in the midst of them. Figure 33 is a longitudinal section through the flange, line *a-b* on Figure 35, and magnified four diameters. This shows the depth to which pronounced heat cracks *a-a-a* will penetrate before developing a flange crack. Figure 34 is a portion of the flange which has been polished and magnified fifty diameters and shows how the surface of the steel is broken up by heat cracks, like sun-dried clay. The large cracks *a-a-a* are the transverse cracks from which the flange fractures originated, and correspond to those shown in Figure 33. Figure 35 is a cross section through the flange, magnified about two diameters, and lightly etched to show the depth to which the heating effect of the shoe has hardened the steel. This is shown on the illustration by the line *c-d.* Figures 36 and 37 show the fractured surfaces of two tires and the origin of the fractures are clearly traceable to a detailed flange crack. The extent of the crack before the tires broke are plainly shown on the prints lines *a-b.*

In the case of broken driving wheel tires these are found usually to have closely approached or passed the limit of road wear. In addition to failures from flange fractures originating from heat cracks, there have been quite a number of failures due to the lightness of design of cast steel driving wheel centers. On account of this lightness of design the tire has not a sufficiently rigid backing and when it begins to approach or reaches the usual limit of road wear the strains due to flexion of the tire are likely to cause failures.

LOOSE TIRES

Breakages from this cause are confined usually to thin tires, and are due to detailed fractures, originating in the bore from repeated

bending stresses. Figure 38 shows the fracture of such a tire and how the fracture progressed by detail until only the light colored area remained when the break took place. Failures of this kind are not common as the tires are readily detected and are generally removed by the inspectors on account of being loose.

President Seley: It is a matter of regret, owing to printer's troubles, that a paper such as this one is, could not have been distributed to members early enough to have received study and consideration so that it could receive most intelligent discussion. I trust, however, that members will say what they have in their minds on the subject.

The paper deals with one of the most important details used on rolling stock and which vitally concerns safety as well as economic features. It is well to separate these two considerations and to see to it that both are fully appreciated and satisfied.

There has been such an enormous demand for steel for all purposes that the facilities and methods for its production have been many times multiplied, and at the same time, revised as to the process, so as to increase output. Whether or not, in this vast development, quality has not been sacrificed somewhat to quantity is a question.

If you will pardon a digression from the specific subject of the evening, I would like to enlarge just a little on the last named consideration.

Take, for example, the matter of rails; the number of breakages of which has attracted attention and resulted in a vast amount of data being collected, sections being studied, methods of production scrutinized and an improvement sought, both by rail makers and users. Owing to the increases in weight and speed carried, it is of the utmost importance that the quality of rails be bettered for increased safety under the above conditions rather than be lowered for the sake of quantity.

Take the question of steel for springs for rolling stock. Many cases have come to my notice where the number of leaves or size of coils should be increased in order to hold up under no increase in weight carried or service required. The indications of such cases are that the quality of steel used is inferior to that formerly employed, and if the inference is correct and is a general proposition, then the formulae for springs must be revised to meet the new condition. Would it not be better, however, to use better steel saying in weight and repairs than to sacrifice the quality and service to quantity?

The paper of the evening takes up the question of steel suitable for steel wheels, discusses the long and short ingot and endeavors

to account for the defects with which steel tires are afflicted, apparently making a case against the railroads for defects developed rather than admitting anything can be wrong with the steel or with the process by which the tires are made. I may have made the last statement a little strong, as on second thought I find a few references to inherent defects and the cuts, Figs. 7, 29, and 30, show them. In the main, however, as I understand it, the claim is made that shelly treads of steel tires are caused by condition in use, over which the maker has no control.

I understand that the author of the paper invites full and free discussion, the object being to bring about any possible improvement in the art that will conduce to safety as well as to quality and quantity of production. After the members have fully expressed themselves, and asked any questions they desire answered, Mr. Norris will take pleasure, I am sure, in replying and closing the discussion. Gentlemen, the paper is now open to discussion.

Mr. A. E. Manchester (C. M. & St. P. Ry.): We have with us tonight Mr. S. M. Vauclain, of the Baldwin Locomotive Works, who leaves on one of the evening trains and I know that all of the members present will want to hear what he has to say before he goes away, so I ask that you will bear him in mind, Mr President and see that he gets a chance a few minutes before ten o'clock at least to express himself on this subject He will be very glad, I presume, to answer questions that may be raised before he gets to his feet, and I therefore hope that if the members have anything to say in the line of questions, they will ask them early in the discussion

President Seley: I would suggest, Mr. Manchester, that you ask your questions as long as you are on your feet. I had Mr. Vauclain in mind to call on him in due course of time. Mr. Wickhorst, will you open the discussion?

Mr. M. H. Wickhorst: (C. B. & Q. Ry.): I do not believe I have very much to say on the subject. It is only recently that I have seen anything of shelly tires and I really do not know whether to side in very thoroughly with Mr. Norris or not. The explanation given of the conditions producing the shelliness seems to me to be correct, and yet I am not altogether sure that there is not something in the material itself that will act as contributory to this tendency to break down. As I said, personally I have not seen enough of shelly tires to form very much of a conclusion.

H. T. Bentley (C. & N. W. Ry.): I can hardly agree with Mr. Norris that the trouble is entirely due to slippage or sliding of the tire on the rail. We have had more trouble, probably, on trailer tires than any other tire on engine or tender and with a few I have noticed, the trouble has occurred on one tire only, and if it were due to slipping on the rail, the trouble would be on both equally, provided there was the same weight distribution and braking power. We frequently have had trailer tires that cracked circumferen-

tially on the tread and pieces sloughed off on one side, while, on the other side, they were absolutely good, so that if it is due to the slippage of the tire on the rail, the material in the tire is not uniform, or both tires would do the same thing.

Another thing that has worried me more than anything else is flange cracks. Mr. Norris seems to think that that is due to the application of the brakes. Well, we certainly have to use brakes on our trains to stop them, and it seems to me that we ought to have a tire that would withstand the service that we expect to give it.

Another peculiarity about that—something was said about the flange of shoe rubbing hard against the flange of the wheel. I have seen a case where three out of four tires on an engine were absolutely all right, and the fourth one would be flange cracked all the way around. It is a very serious condition, and when I see those cracks, or anybody sees them, it makes them wonder what is going to happen. If there is anything that manufacturers can do to toughen or harden the steel so that the brake shoes will not have an injurious effect on it, I think it is worthy of their consideration.

President Seley: Mr. Manchester, cannot you put a thorn into Mr. Vauclain's side?

Mr. A. E. Manchester (C. M. & St. P. Ry.): Mr. President, it is a self-evident fact that there are defects in tires. If the user is responsible for a part, or a very large part of these defects, we would be glad to have the makers suggest what in their judgment we could do in the line of eliminating the trouble. My own experience with tires has been largely in the line of defects that the maker was responsible for. The shelly spots that I have examined were not such surface defects as to lead me to believe that the trouble was not in the tire. In fact, as a general proposition, it has taken in many cases one half inch of turning to get below the bad spot and get down to good metal.

As to the surface hardening that has been shown on the slides, due, possibly, to the sliding, would any other carbon or manganese have been liable to produce this hardening? What has been the results of the investigation of tires made in foreign countries, where it is shown they use a different chemical composition than is used here? Have any of those who have studied this feature any information on that line? I would like to hear that discussed. Also, has this same character of defects been as prominent in the crucible tire as in the open hearth?

As to the cracks in the top of the flange, as has been explained in the paper, due, possibly to the lightness of the felly of the wheel, my observation has been in the direction that this has been the probable cause of tire failures from flange cracks, and I have never been satisfied that the flange brakeshoe has been the cause of the starting of these cracks.

Mr. Bently: I would like to ask Mr. Manchester if he has noticed the same as I have, with four driving wheels under an engine all with the same section of wheel center, that one wheel would develop these flange cracks and the other three would not do so, which would seem to indicate that it was not the strength of the wheel center which was responsible for the cracking?

Mr. Manchester: I will have to say that that has been my observation; that there is generally but one tire on a set of tires that will develop these peculiar cracks, but I am not prepared to say that that wheel was not the one that was the most liable to deflection and that that was the real cause, although if any difference in the chemical composition of the tire leads up to that crack, that might possibly be the cause. I believe that every tire made from the same ingot may not show the same chemical analysis and in fact, if the chemical analysis in tire steel follows along the same lines as in boiler plate, I know that you can get several kinds of analysis out of different portions of the same sheet, and if the sheet was tested from several points, it would be frequently scrapped or rejected as not coming within the limits of the chemical specifications.

Mr. Wickhorst: Personally, I do not think Mr. Bentley's argument is very strong in favor of the point that he is trying to make, that is the fault is with the steel; if anything, I would be quite as likely to look for something wrong with the mounting or some difference in the diameter for instance, that was responsible. I can also easily imagine conditions arising where the slivering can work itself down through one-half inch of what was originally good, sound metal as mentioned by Mr. Manchester. I have studied lately somewhat the matter of rails on curves, and we have there a case of what slippage will do toward flowing the metal. Take the inside rail of any curve and you practically always find the metal flowed. The wheels in every case go to the outside rail, which means that the flange cuts the outside rail and it also brings the false flange, as it were, onto the inside rail, and furthermore, we have a slippage on the inside rail, and for that reason the inside rail will in almost all cases show the effects of flow of metal due to the increased weight on the outside portion at the head and of the slippage of the inside wheel. I mention that simply as showing that, if, instead of putting the stresses on the rail we transfer them to the tire, we may expect a great deal the same result in the tire as Mr. Norris explains. At the same time, if the metal is not of a good or suitable quality, it is going to get into the condition very much sooner.

President Seley: I think the theory presented here is a very interesting one and will bear considerable investigation, and I would like to have Mr. Norris tell us in his closing as to how extended the investigation was, as to whether these slides that have been

shown and conclusions drawn therefrom have been from a large number of tires and if the weight under which those tires were worn was known and all the conditions from the life of the tire. Mr. La Rue, may we hear from you?

Mr. H. La Rue (C. R. I. & P. Ry.): Mr. President, I think some of the conditions named by Mr. Norris in regard to the shelling of wheels is probably correct, at the same time in many cases I believe the fault rather lies more with the maker than with the user. It has been my experience recently that manufacturers have disregarded many of the details in the manufacture of wheels that are necessary to their success. For instance, wheels have come marked and mated and when mounted, and if for some reason or other you mistrust that the mating marks are not correct, they are put in the lathe and you will find very often a difference of one-eighth to five-sixteenths of an inch in the same pair of wheels. If the wheels are put into service in that condition, I do not think it is right to charge the eccentricity of the wheel and the wearing of it up to the user. We also find, even when it comes to mounting the wheels, they do not take as much pains in boring them as they should. You will find wheels with taper bores, you will find hubs, some of them 6½ inches, some of them 7 inches through. If the same condition exists in the manufacture of the tire that there does in the finishing of the wheel, what else can we expect than what we find to-day in regard to the shelly tire?

There is another condition that has come to my notice. If a slight shelly place is detected on a wheel and it is taken out and turned, that condition seems to disappear after the first turning of the tire. Also, my foreman reports that there seems to be a difference in the composition of the tire, or as he calls it, "the temper" of it, that where these spots occur, it is of a different color. The tool used in the turning of wheels will perform its work differently on that spot than it will on the other part of the wheel, and there is a difference in the color where these shelly spots are, whether they are five inches long or forty inches long; you can tell that color by standing off fifteen to twenty feet from the wheel. I believe that a great deal of this is in the composition, as you may call it, or you might not call it that, in the making of the tire or the mixture of the steel. I do not think that the users of the wheels should be charged with all these defects in these tires, nor do I think we should be charged up with the brake-slides. I do not think that the braking power is as heavy on wheels under 100,000 lb. tanks as it is proportionately under 60,000-lb. cars. I am not inclined to believe with the writer of the paper that all these defects are chargeable to the users of the wheels.

President Seley: Mr. Wallace, may we hear from you?

Mr. W. G. Wallace: Mr. President, I did not have an opportunity to study the paper and I am not prepared to talk on it.

President Seley: The paper is open for discussion gentlemen, to any one who cares to have anything to say. Mr. Vauclain, will you take the floor?

Mr. S. M. Vauclain (Baldwin Locomotive Works): Mr. President and Members of the Western Railway Club, I came out here this evening to listen and learn and not to talk, but Mr. Seley seems determined to hear from me upon this very important subject, and while it is very important to the railway, that is, the use of steel tires, it is very much more important to the manufacturer of steel tires on account of the large and rapid increase that we are having in the use of material of this kind and the substitution in many cases of solid forged steel wheels for cast iron chilled wheels in heavy freight service and especially in the heavy service under locomotive tenders for which we have previously in freight service used the chilled wheel with very poor success.

In Mr. Norris's report there are one or two things that I should take exception to if I were not a manufacturer or a railway man, but if I were an engineer of a locomotive, and one of those things is his allusion to the trailer wheels of passenger locomotives lifting up. I do not see how it is possible to lift the trailer wheel of a locomotive, for in almost every case the brake shoe is so applied that the weight bears upon the wheel and holds the wheel upon the track and in no way could this wheel lift; the location mentioned would cause the wheel to be drawn up in its pedestal and the entire weight carried by the other wheels of the locomotive.

There are some general conclusions in this report that, although I am a manufacturer of steel tires, I cannot agree with, and the reason why I cannot agree with them is that I have been in the railroad business myself, and there are certain concrete conclusions that one arrrives at in the railway business that no amount of scientific exploitation can banish from one's mind. For instance, if we have on an engine truck or a tender truck four wheels, all supposed to be good wheels when they are put in service and if later on we have to remove one wheel or one pair of wheels on account of one wheel being defective, having a shelly tread, or some other minor defect, if would appear that something must be wrong with the steel, and that is exactly the way I think about this question.

I feel that Mr. Norris is entirely correct in all the conclusions that he has arrived at, and in the manner in which he has investigated every sample of defective tires that may have come to his notice. I feel, however, that a railroad is built through a section of country because that country needs a railroad. I feel also that wheels are made to run over that railroad after it is built and that we must endeavor to make wheels that will be satisfactory and give satisfactory service under the equipment that is used on that particular railroad. Mr. Seley, in his opening remarks in presenting this matter before the Club for discussion, rather hinted that we

were pursuing the same course in the manufacture of locomotive and car wheel tires as that purused by the rail maker. Now, of course I have troubles of my own, and I propose to leave the rail maker to his, but I assure you that the rapid manufacture of tires has nothing whatever to do with it, that is, the process now used being a more rapid process for the manufacture of tires than the processes previously used. It is a more laborious one, and a more costly one, and one that is calculated to cast out many defective pieces of steel that under the old process would be made up into tires and turned into service. Each course that this material is passed through offers an opportunity for inspection and examination, and finally, after a tire is rolled, every tire that is shipped from the particular works in which I am interested is turned all over, inside and outside, and on both faces, even though it is sold as a rough tire. This is in order that we may discover any defects upon the surface which may manifest themselves and keep our troubles at home rather than have them spread out all over the United States.

The open hearth acid process for making steel is of course the only process that can be used; it has also been demonstrated that the long ingot process is the best process used. We have made steel tires by the acid process that have gone into competition with foreign tires made by the crucible process, which have outworn those tires and excelled them from every point of view, and the same quality of material as was used in those cases is used on the American tire to-day. Mr. Manchester is entirely right, however, in that it is impossible to cast every ingot and every heat of steel with exactly the same chemical composition. You can come very close to it. It is impossible to treat every tire with the same degree of heat or every tire bloom that has come from the ingot, and there is an opportunity for slight variation in quality or density of a would-be tire on that account, but that does not say that the tire maker does not use due diligence.

The trouble with steel rails and the trouble which some roads have experienced with shelly tires, for the past twelve months I think has affected less than one half of one per cent of all tires manufactured, but a question as to rails.

The United States government has gotten into some trouble with seams or streaks in material which was furnished for high power guns, and with a view of determining, if possible, what this trouble may be due to, a very large sum of money has been appropriated for the purpose of thoroughly investigating the subject and finding out, if possible, if there may be a way by which steel ingots can be cast that will free them from these particular lines or seams which gave them so much annoyance. A committee appointed by the Watertown Inspection Department in which Mr. Howard who has charge of the Watertown Laboratory Testing Plant was included, visited me and asked whether I had any objection to their visiting

the Standard Steel Company's plant with a view of investigating our method of casting steel forging ingots and forging the steel after it had been cast, and whether I would in any way co-operate with them to determine if there might be some way in which steel could be better made. I replied that nothing would give us more pleasure, that we would give him an ingot or a carload of ingots, we would make him a forging or a carload of forgings, we would make him test pieces, we would assist him in any way, shape or form that he might desire, on one condition, that he give us a complete history of his experiments and the conclusions that he might arrive at. On my visit West I fortunately brought with me a copy of the letter which I received from one of his associates, and I will read it:

"Dear Sir: I desire to thank you for the facilities given Mr. James Howard and myself at the Standard Steel Works last Tuesday to investigate every step in the manufacture of your steel products. We were particularly interested in the structure of the ingot and of the finished tire. We examined carefully every step, starting from the ingot, to the casting. We did not find many shrinkage cracks in the bottom cast ingots and in nearly every case the cause of the crack was due to the old method of casting. In the present method of using round ended ingots with large end-up, all the trouble of shrinkage cracks has been eliminated. The ingots were cut on the lathe and a large portion of the center broken, giving us an opportunity to follow the structure of the ingot from one end to the other, and in all the ingots we examined we could not find any blow holes at the edge or defects in the center portion of the ingot. The only imperfections, if they may be so called, were the pipings at the top of the ingots which was cut off with the nigger-head. We followed up the finished material in order to see if defects could be found in the tire, or the large double flange wheels that were being rolled, but no defects of any kind could be seen on the machined surfaces and we then tried iodine on the surfaces to bring out if possible streaks which have caused so much trouble in gun forgings, but we could not find any streaks in your steel. Mr. Howard selected one of your heats of tire steel that will be treated in the usual method of manufacture and samples taken at different stages, which will be tested both physically and microscopically at Watertown to see if there really are any streaks or other defects in this material.

It was thought by Mr. Howard, Mr. Stevenson, and myself that it would be of the greatest interest to have some of your octagonal ingots rolled into rails in order to see if lines of weakness could be developed in them as are usually found in the ordinary rails of today. The longitudinal and transverse bends sliced from the flanges of your tires did not develop lines of weakness as shown by the tests of rails made at Watertown by Mr. Howard. If you could

assist in having some of your ingots rolled into rails of 80 or 100 lbs. per yard you will confer a great favor upon."————

Now, I want to explain that we started to make some ingots which were flat on the bottom. Our former process had been to make ingots round on the bottom. We soon discovered that flat bottoms were a mistake, that in casting them on the bottom the ingot created defects in itself by a shrinking and chilling and by other conditions dependent upon the shape of the ingot, so we immediately altered all our moulds to go back to the old process, which he now refers to as the new process, because all the ingots we had made by that process were used up, but all the ingots now being made and that have been made for the last few months, are being made by the round bottom process, and in every case the cause of the crack was due to the old method of casting. In the present method of using round bottom ingots with the large end up, all the trouble of shrinkage cracks has been eliminated.

In our steel ingots, as the metal chills, the top of the ingot, or the head of the ingot, sinks down and if we do not employ some means of keeping the metal liquid at the top until it has time to thoroughly settle and solidify from the bottom up, we are likely to get a contracting pipe, which may extend a considerable distance into the ingot, but by the process which we have discovered and use, we cover that from the atmosphere and have a very simple funnel-shaped depression which is afterwards cut off and gives clear metal to flow in.

Then he asks if I will assist in having some ingots rolled into rails as he suggests for service. Now, it is very complimentary indeed to get a letter of that sort just at this time when there is so much discussion in regard to the quality of steel as made by the large steel industries of this country and by the small ones, too, so we feel we are doing everything the manufacturer can do to get good material; no expense is spared. We could not sell these ingots to a rail-maker to roll rails from at a less price than the railroad company now pays for rails rolled, so that if we could make steel that we thought would make satisfactory tires as cheaply as we can make steel of which we can make rails and roll them for $28 a ton, we could make a very much better profit out of the tire business and wheel business than we now make, but in all our manufactures—and I feel that is true of other tire manufacturers, at least I hope it is—that the question of the cost or price of tire or wheel has not the slightest influence upon the men who are responsible for the quality of material which goes into that tire.

Some of the theories advanced here tonight in regard to some of the defects as shown by the lantern slides, personally I am not in accord with. I cannot tell our people how to cure it. I have to accept their scientific explanation until I can get a better one. The Board of Directors of the Standard Steel Works, however, are

determined that if a better tire can be made, if these defects which occur in service can be minimized, or eliminated, they will be eliminated, and we have eliminated I should think the larger portion of the defects which we found in tires ten years ago. At least the results of our business indicate that that is true.

The question raised by the gentleman from the Northwestern I think is a good one. I cannot see how the flange of a driving brake shoe can put radial cracks in the flange of the tire on one wheel out of four unless the other three driving wheels have no flange rims on them; I could understand it if that were the case, but I think it must be due to some condition that exists in that particular tire. I am sure we will find it; we may not find it very soon, but I think we will ultimately be able to make tires that will not show up these particular defects. We must all realize that the service is more severe than formerly, that the loads carried are very much heavier. Ten years ago the maximum load that was permitted by one of the leading roads running out of Chicago was 33,000 pounds per driving axle, or about 16,500 pounds per wheel. The limit to-day is 50,000, and 60,000 pounds per driving wheel and is becoming a common load for us at the present time. It follows, therefore, that if the tire maker had not been busy for the last ten years in improving his tire, in taking more time to produce a certain tonnage, to eliminate defects, to study the use to which tires are put, that we would have at least ten times more trouble than we now have from shelly tread tires.

It will give me pleasure gentlemen to answer any questions which you may wish to ask me. I have nothing further, however, to say myself. (Applause.)

President Seley: We are very greatly obliged to Mr. Vauclain and I am glad my little stinger had its results. Is there any further discussion? Mr. Jeffries have the locomotive engineers anything to say on this subject?

Mr. B. H. Jeffries (Wabash Ry.): There was one point that struck me as interesting to know. Mr. Norris said that shelling is caused, as I understand it, by the heat caused by the friction of the brake shoe sliding the wheel on the rail. It seems to me it would be interesting to know what the temperature was when that shelling took place, and that if the wheels shelled more in real hot weather than they did when the thermometer was about 20 below zero; it seems that that would have some bearing on the subject if that were known.

President Seley: Any further discussion? If not, we will ask Mr. Norris to close.

Mr. Norris: In answer to the question by the President I would say that this investigation has covered a period of several years, in the course of which a great many tires were examined, by etching transverse and other sections, by chemical analysis, the usual physical tests, and by microscopic examinations. Altogether we have

made, I suppose, 700 or 800 microscopic examinations of as many distinct sections, many of them from the same tire. For a long time we studied tires which were sent in by the railroads, but we found that most of these were very badly shelled, having been kept in service until hardly recognizable as a tire, and studying them was something like trying to diagnose the disease from which an Egyptian mummy died. During the last few years we have studied the matter in the field, investigating conditions of service on the roads having the most trouble, and tracing shelliness from its incipient stages. All the evidence gained by these investigations seems to point to the conclusion that I have presented in this paper.

As to the influence of weather conditions, I think more trouble is experienced in winter with broken rails and broken and shelly tires, on account of increased servity of operating conditions. This theory of the shelling originating from hard slip spots would naturally lead us to expect this; we would also expect the intensity of the hardening effect of the slipping to be greater in cold weather due to the more rapid quenching, so to speak, of the intensely heated slip spot in contact with the rail. We find on the head of the rail slip and slide spots, and we know that the tire must have been marked just the same as the rail, for two pieces of steel cannot be rubbed together under such conditions without both being affected. It has been my observation that wheels on the opposite ends of the same axle, as well as wheels in the same truck, are not always affected alike by brake application. It is frequently found on examination of a pair of wheels that have been seen to slide, that the slid spot on one wheel is considerably larger than on the other.

It is natural to suppose then that there was a greater area of contact between the rail and the wheel, due possibly to a greater load over that particular wheel, or a number of other conditions. This difference in size of the slid spot has frequently been noted when the tires on the wheels have been made from the same ingot, and also when they were cut from corresponding positions of different ingots of the same heat of steel. This would seem to eliminate the question of difference in hardness or quality of the two tires being the cause of difference in size of the slid spots.

In regard to Mr. Bentley's observation of only one tire out of a set of four showing flange cracks, I would say I have frequently noticed a difference in the depth and number of heat cracks not only in the same set but on the same tire. I do not attribute this to the quality of the steel in the tire, but to differences in the section of the flanges, eccentricity of the wheel, and possibly differences in the dimensions of the flange groove in the shoes.

Mr. Bentley: I move that a vote of thanks be given to Mr. Norris for this very interesting paper.

Motion was seconded and carried unanimously.

President: If there is no further business, a motion to adjourn will be in order.

Adjourned.

The David L. Barnes Library

SPECIAL NOTICE.

The David L. Barnes Library of this Club, at 390 Old Colony Bldg., Chicago, is open for the use of members and their friends, and we hope it will be used freely. It is open on week days from 9 a. m. to 5:30 p. m., except on Saturday, until 3 p. m. Books must not be removed from Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel, on Tuesday evening, Nov. 19, 1907. President C. A. Seley in the chair. The meeting was called to order by the President at 8 P. M. The following members registered:

Allison, W. L.
Arlein, E. J.
Axtell, G. F.
Ayers, A. R.
Baker, C. M.
Barnes, C. A.
Barnum, M. K.
Barton, T. F.
Bently, H. T.
Brooks, P.R.
Bryant, Geo. H.
Buell, D. C.
Callahan, J. P.
Carlton, L. M.
Chadwick, A. B.
Christenson, A.
Cooke, W. J.
Crawford, J. G.
Cunningham, A. J.
Endsley, L. E.
Feldhake, J. M.
Fenn, F. C. D.
Fisher, Oscar A.
Flavin, J. T.
Fogg, J. W.
Forsyth, Wm.
Fosdick, F. C.
Fry, C. H.
Furry, F. W.
Furry, W. S.
Gale, Wm. T.
Garrett, M. A.
Gennet, C. W. Jr.
Hahn, F. W.
Haig, M. H.
Hall, W. B.
Hammond, W. S. Jr.
Harkness, F. L.
Hatch, H. B.
Higgins, C. C.
Hinds, J. B. L.
Hidgkins, E. W.
Hopkins, G. H.
Hunter, P.
Kelley, H. D.
Kerwin, E. M.
LaRue, H.
Lawrence, W. I.
Lewis, J. H.
Little, J. C.
Lickey, T. G.
Lowder, R. S.
McAlpine, A. R.
McClain, H. O.
McRae, J. A.
MacKenzie, D. R.
Medland, W. C.
Meeder, W. R.
Mohle, C. E.
Monroe, M. S.
Moore, C. B.
Naylor, C. R.
Neff, J. P.
Newsom, H. H.
Osmer, J. E.
Parker, P.
Peck, P. H.
Price, R. C.
Raidler, W. P.
Robb, J. M.
Schlacks, W. J.
Seley, C. A.
Setchel, J. H.
Sharp, W. E.
Shumate, F. D.
Smith, W. R.
Stott, A. J.
Studer, A. L.
Sweringen, G. N.
Symons, W. E.
Taft, R. C.
Talmage, J. G.
Tawse, W. G.
Taylor, J. W.
Thomas, C. W.
Tinker, J. H.
Towsley, C. A.
Warner, H. E.
Wolfe, F. E.
Wright, L. S.
Wright, Wm.
Zealand, T. H.

PRESIDENT SELEY: The meeting will please come to order. The minutes of the last meeting having been printed and distributed will be considered as approved unless objection is made.

The next is the report of the secretary.

THE SECRETARY: Mr. President, I have the usual membership statement:

MEMBERSHIP STATEMENT.

Membership October		1422
Resigned	3	
Dropped—non-payment of dues	6	9
		1413
New members approved by Board		14
Total		1427

NEW MEMBERS.

	NAME ADDRESS	PROPOSED BY
1	John Troy, Foreman Boiler Shop P. M. R. R., Saginaw, Mich.	S. L. Moffitt
2	F. R. Austin, Auditor, E. & T. H. R. R., Evansville, Ind.	E. H. DeGroot, Jr.
3	H. O. McClain, Draftsman, I. C. R. R., Chicago, Ill.	G. F. Axtell
4	J. H. Houck, Supt. Hamler Boiler & Tank Co., Chicago, Ill.	W. E. Sharp
5	J. R. Hamliton, Draftsman Armour & Co., Chicago, Ill.	W. E. Sharp
6	A. W. Clement, Sales Agt. Ohio Brass Co., Mansfield, Ohio	C. H. Fry
7	Carl Penner, Standard Metal Mfg. Co., Chicago, Ill.	D. C. Barber
8.	W. T. Sherman, U. S. Lighting & Heating Co., Chicago, Ill.	H. E. Tucker
9	Geo. Kleifgen, N. Y. Air Brake Co., Chicago, Ill.	H. E. Tucker
10	J. E. Forsyth, Forsyth Auto. Air & Steam Coupler Co., Chicago, Ill.	H. E. Tucker
11	C. P. Lovell, N. Y. Air Brake Co., Chicago, Ill.	H. E. Tucker
12	W. F. Bowers, Ill. Central R. R., Chicago, Ill.	H. E. Tucker
13	M. B. Lambert, Engr. Westinghouse B. & M. Co., Chicago, Ill.	G. H. Hopkins
14	A. J. Chapman, C. C. Shop Acct. C. I. & S. R. R., Hammond, Ind.	J. B. L. Hinds

RESIGNED.

Ben Johnson, S. M. P. Mex. Central Ry., Aguascalientes, Mex.
Geo. Espey, Signal Engr. C. & W. I. R. R., Chicago, Ill.
E. B. Farmer, Westinghouse Air Brake Co., St. Paul, Minn.

DROPPED—NON-PAYMENT OF DUES.

C. A. Lichty, C. & N. W. Ry., Chicago, Ill.
E. P. Marsh, C. & N. W. Ry., Chicago, Ill.
C. W. Martin, Consol. Car Heating Co., Chicago, Ill.
W. F. McCormick, Chicago Ill.
W. J. McLeish, S. M. P. E & T. H. R. R., Evansville, Ind.
W. K. Millholland, Gisholt Mfg. Co., Chicago, Ill.

PRESIDENT SELEY: The next business will be the reading of the paper of the evening: "The Influence of Heat Value and Distribution on Railway Fuel Cost," by Mr. J. G. Crawford, Fuel Engineer, C. B. & Q. Ry. I have the pleasure of introducing Mr. Crawford.

THE INFLUENCE OF HEAT VALUE AND DISTRIBUTION ON RAILWAY FUEL COST.

By Mr. J. G. Crawford, Fuel Engineer, C. B. & Q. R. R.

The cost of locomotive fuel is about 12 per cent of the total operating expenses of a railroad, and consequently the subject of fuel economy is of the utmost importance.

It is not the purpose of this paper to discuss the economical use of coal on locomotives, but to deal with the economical purchase and supply of coal before it reaches the locomotives. In order that coal may be economically purchased and distributed the heat value and cost must be considered.

The heat value of coal may be determined by laboratory calorimeter tests or by evaporation tests made on locomotives. The latter method is preferable, as the coal is tested in actual service.

LOCOMOTIVE COAL TESTS.

The heat values of the coals found on or near the railroad system which are being or are likely to be used, should be determined by locomotive evaporation tests. The coals should be tested in groups, and in order that different groups of coals may be compared, even though the tests are made 1500 miles apart, each group of tests as well as the individual tests should be carried on under similar conditions.

The unit of comparison for coals is the number of pounds of equivalent water evaporated per pound of coal. It is evident that the following items will affect this ratio or unit of comparison: Kind of Coal; Class of Engine; Condition of Engine; Engine Crew, especially the fireman; Class of Service.

Since the object of coal tests is to determine the comparative value of various coals, all others of the above conditions should be kept as uniform as possible. These items will be referred to below.

SELECTIONS OF DIVISION FOR TESTS.

Coals should be tested on a division where they are being used, as the firemen are already accustomed to them. When coals which differ materially from those habitually used are to be tested, a number of trial runs must be made until the firemen can properly fire the coal.

CLASS OF ENGINE.

If possible all the tests made on one railroad system should be made on one class of engine. This is advisable in order that the coals tested at one end of the system can be compared with those

tested at the other end without having to correct for the difference in evaporative efficiencies of the engines.

CONDITION OF ENGINE.

Engines should always be in good condition, and this applies especially to condition of flues and firebox.

Whether a brick arch is used or not, the conditions in this particular should be the same in all tests.

ENGINE CREWS.

During a series of tests the same firemen should be used throughout, thus avoiding any difference on this account. It is not so important that the same engineers be used, for while one engineer may use more steam than the other, the ratio of the coal to the water used will not change materially.

CLASS OF SERVICE.

Passenger is preferable to freight service on account of the more uniform conditions. It is desirable that the time between terminals, the time using steam and the weight of the trains shall be nearly uniform from day to day, and that the average of these values for all tests made with each kind of coal shall be nearly the same.

When tests are conducted in freight service at least twice the length of time will be required to test one kind of coal, and the expense will be more than doubled on account of additional coal weighers being required.

ORGANIZATION OF TEST PARTY.

At each terminal a fuel tester is located to take charge of the supply and weighing of the test coal and to see that none of the weighed coal on the engine is used during its stay at the terminal.

The coal weigher is relieved by an engine observer before the engine leaves the round house, and he stays with the engine until relieved by the coal weigher at the other terminal. The engine observer keeps record of coal, water, steam pressures, stops, shut-offs, etc., in a printed thumb-indexed note book made up of seven printed forms and three blank pages. The note book and details of the individual pages are shown in Fig. 1.

From four to eight men are required to make the tests properly, according to whether one or two engines are used and whether they are single or double crewed.

NUMBER OF TESTS.

Exclusive of that used for firing up, about 150 tons of each kind of coal should be used on the tests.

From six to eight round trips are made with each coal, and where two firemen are used half the tests are made with each fireman. This is necessary, as one fireman might be slightly better than the other.

Tests in one direction on account of grades, speed or number of

cars may be more favorable than in the other, hence the same number of trips in each direction are necessary.

RESULTS.

The data taken for each test are recorded on blanks shown in Fig. 1, and the more important totals and averages recorded on the final result sheet of which Fig. 2 is a reproduction. The data and computations of each test are recorded in a column and the average for all tests in the average column.

In a series of tests which have all been conducted under similar conditions, the heat value of each coal is proportional to the average of items No. 35 which shows the equivalent number of pounds of water evaporated from and at 212 degrees per pound of coal.

The results covering the A. B. C. Railroad will be expressed as follows:

Name of Coal.	Equivalent Evaporation per Pound of Coal, Actual.	Rank.	Price per Ton.
"A"	5.60	80.0%	$1.50
"B"	5.60	80.0	1.30
"C"	6.30	90.0	1.30
"D"	6.30	90.0	1.60
"E"	7.00	100.0	1.30
"F"	7.00	100.0	1.10
"G"	7.70	110.0	1.40
"H"	7.70	110.0	1.20
"I"	8.40	120.0	2.10
"J"	8.40	120.0	2.50

The above coals do not necessarily represent individual companies or mines, but coals of equal heat value and price from the same point of distribution are included under one name.

For convenience the coals have been assumed to be poorer and better than the standard coal by multiples of 10 per cent. The prices selected in most cases bear little or no relation to the heat value which is true under actual conditions.

COAL DISTRIBUTION A. B. C. RAILROAD.

For convenience the A. B. C. Railroad System, as shown in Fig. 3, has been assumed as having the following requirements and conditions:

(1) Coaling stations require respectively the equivalent of 100, 200 and 300 tons of standard (100%) coal per day.

(2) That the railroad can get as much coal as it desires from all the sources of supply.

(3) That all these coals will mix with each other without additional trouble from clinkering, etc.

(4) Cost of handling at chutes, ten cents per ton.

Table No. 1

A. B. C. RAILROAD COMPANY.

PRESENT COAL DISTRIBUTION AND COST OF COAL PER DAY.

Stations.	Tons Standard Coal Required	COAL BEING USED. Kind.	Tons	Per Ton. Cost	HAULAGE. Miles	Ton-Miles.	COST OF COAL BY STATIONS. First Cost.	Hauling.	Handling.	Total.
1	200	A	250.0	$1.50	0	0	$ 375.00	$ .00	$ 25.00	$ 400.00
2	100	A	125.0	1.50	50	6,250	187.50	12.50	12.50	212.50
3	100	A	125.0	1.50	100	12,500	187.50	15.00	12.50	225.00
4	300	A	375.0	1.50	150	56,250	562.50	112.50	37.50	712.50
5	100	D	111.1	1.60	200	22,220	177.76	44.44	11.11	233.31
6	100	D	111.1	1.60	250	27,775	177.76	55.55	11.11	244.42
7	200	D	222.2	1.60	300	66,660	355.52	133.32	22.22	511.06
8	100	D	111.1	1.60	350	38,885	177.76	77.77	11.11	266.64
9	100	D	111.1	1.60	400	44,440	177.76	88.88	11.11	277.75
10	200	D	222.2	1.60	450	99,990	355.52	199.98	22.22	577.72
38	100	I	83.3	2.10	250	20,825	174.93	41.65	8.33	224.91
39	100	I	83.3	2.10	200	16,660	174.93	33.32	8.33	216.58
40	200	I	166.6	2.10	150	24,990	349.86	49.98	16.66	416.50
41	100	I	83.3	2.10	100	8,330	174.93	16.66	8.33	199.92
42	100	I	83.3	2.10	50	4,165	174.93	8.33	8.33	191.59
43	200	I	166.6	2.10	0	0	349.86	.00	16.66	366.52
11	100	E	100.0	1.30	100	10,000	130.00	20.00	10.00	160.00
12	100	E	100.0	1.30	50	5,000	130.00	10.00	10.00	150.00
13	300	E	300.0	1.30	0	0	390.00	.00	30.00	420.00
26	100	E	100.0	1.30	50	5,000	130.00	10.00	10.00	150.00
27	100	E	100.0	1.30	100	10,000	130.00	20.00	10.00	160.00
14	100	C	111.1	1.30	400	44,440	144.43	88.88	11.11	244.42
15	100	C	111.1	1.30	350	38,885	144.43	77.77	11.11	233.31
16	200	C	222.2	1.30	300	66,660	288.86	133.32	22.22	444.40
17	100	C	111.1	1.30	250	27,775	144.43	55.55	11.11	211.09
18	100	B	125.0	1.30	200	25,000	162.50	50.00	12.50	225.00
19	200	B	250.0	1.30	150	37,500	325.00	75.00	25.00	425.00
20	100	B	125.0	1.30	100	12,500	162.50	25.00	12.50	200.00
21	100	F	100.0	1.10	200	20,000	110.00	40.00	10.00	160.00
22	200	F	200.0	1.10	150	30,000	220.00	60.00	20.00	300.00
23	100	F	100.0	1.10	100	10,000	110.00	20.00	10.00	140.00
24	100	F	100.0	1.10	50	5,000	110.00	10.00	10.00	130.00
25	200	F	200.0	1.10	0	0	220.00	.00	20.00	240.00
28	200	G	181.8	1.40	450	81,810	254.52	163.62	18.18	436.32
29	100	G	90.9	1.40	400	36,360	127.26	72.72	9.09	209.07
30	100	G	90.9	1.40	350	31,815	127.26	63.63	9.09	199.98
31	200	G	181.8	1.40	300	54,540	254.52	109.08	18.18	381.78
32	100	G	90.9	1.40	250	22,725	127.26	45.45	9.09	181.80
33	100	H	90.9	1.20	200	18,180	109.08	36.36	9.09	154.53
34	200	H	181.8	1.20	150	27,270	218.16	54.54	18.18	290.88
35	100	H	90.9	1.20	100	9,090	109.08	18.18	9.09	136.35
36	100	H	90.9	1.20	50	4,545	109.08	9.09	9.09	127.26
37	200	H	181.8	1.20	0	0	218.16	.00	18.18	236.34
Total. .	6,000		6,158.8			1,084,035	$8,840.55	$2,168.07	$615.83	$11,624.45
Average				$1.44	1.76		1.44	.35	.10	1.89

Table No. 2.

A. B. C. RAILROAD COMPANY.

PROPOSED COAL DISTRIBUTION AND COST OF COAL PER DAY.

Stations.	Tons Standard Coal Required	COAL TO BE USED. Kind.	Tons.	per Ton. Cost	HAULAGE. Miles.	Ton-Miles.	COST OF COAL BY STATIONS. First Cost.	Hauling.	Handling.	Total.
1	200	D	222.2	$1.60	0	0	$ 355.52	$ .00	$ 22.22	$ 377.74
2	100	D	111.1	1.60	50	5,555	177.76	11.11	11.11	199.98
3	100	D	111.1	1.60	100	11,110	177.76	22.22	11.11	211.09
4	300	J	250.0	2.50	0	0	625.00	.00	25.00	650.00
38	100	J	83.3	2.50	50	4,165	208.25	8.33	8.33	224.91
39	100	I	83.3	2.10	200	16,660	174.93	33.32	8.33	216.58
40	200	I	166.6	2.10	150	24,990	349.86	49.98	16.66	416.50
41	100	I	83.3	2.10	100	8,330	174.93	16.66	8.33	199.92
42	100	I	83.3	2.10	50	4,165	174.93	8.33	8.33	191.59
43	200	I	166.6	2.10	0	0	349.86	00	16.66	366.52
5	100	E	100.0	1.30	400	40,000	130.00	80.00	10.00	220.00
6	100	E	100.0	1.30	350	35,000	130.00	70.00	10.00	210.00
7	200	E	200.0	1.30	300	60,000	260.00	120.00	20.00	400.00
8	100	E	100.0	1.30	250	25,000	130,00	50.00	10.00	190.00
9	100	E	100.0	1.30	200	20,000	130.00	40.00	10.00	180.00
10	200	E	200.0	1.30	150	30,000	260.00	60.00	20.00	340.00
11	100	E	100.0	1.30	100	10,000	130.00	20.00	10.00	160.00
12	100	E	100.0	1.30	50	5,000	130.00	10.00	10.00	150.00
13	300	E	300.0	1.30	0	0	390.00	.00	30.00	420.00
14	100	E	100.0	1.30	50	5,000	130.00	10.00	10.00	150.00
15	100	E	100.0	1.30	100	10,000	130.00	20.00	10.00	160.00
16	200	E	200.0	1.30	150	30,000	260.00	60.00	20.00	340.00
17	100	E	100.0	1.30	200	20,000	130.00	40.00	10.00	180.00
26	100	E	100.0	1.30	50	5,000	130.00	10.00	10.00	150.00
27	100	E	100.0	1.30	100	10,000	130.00	20.00	10.00	160.00
28	200	E	200.0	1.30	150	30,000	260.00	60.00	20.00	340.00
29	100	E	100.0	1.30	200	20,000	130.00	40.00	10.00	180.00
18	100	F	100.0	1.10	350	35,000	110.00	70.00	10.00	190.00
19	200	F	200.0	1.10	300	60,000	220.00	120.00	20.00	360.00
20	100	F	100.0	1.10	250	25,000	110.00	50.00	10.00	170.00
21	100	F	100.0	1.10	200	20,000	110.00	40.00	10.00	160.00
22	200	F	200.0	1.10	150	30,000	220.00	60.00	20.00	300.00
23	100	F	100.0	1.10	100	10,000	110.00	20.00	10.00	140.00
24	100	F	100.0	1.10	50	5,000	110.00	10.00	10.00	130.00
25	200	F	200.0	1.10	0	0	110.00	.00	20.00	130.00
30	100	H	90.9	1.20	350	31,815	109.08	63.63	9.09	181.80
31	200	H	181.8	1.20	300	54,540	218.16	109.08	18.18	345.42
32	100	H	90.9	1.20	250	22,725	109.08	45.45	9.09	163.62
33	100	H	90.9	1.20	200	18,180	109.08	36.36	9.09	154.53
34	200	H	181.8	1.20	150	27,270	218.16	54.54	18.18	290.88
35	100	H	90.9	1.20	100	9,090	109.08	18.18	9.09	136.35
36	100	H	90.9	1.20	50	4,545	109.08	9.09	9.09	127.26
37	200	H	181.8	1.20	0	0	218.16	.00	18.18	236.34
Total. .	6,000		5,760.7			783,140	$8,058.68	$1,566.28	$576.07	$10,201.03
Average				$1.40	136		1.40	.27	.10	1.77

Note—At station No. 38 either "J" or "J" coal could be used with equal cost and "J" has been assumed as the coal to be used. Similarly with station No. 18 "F" coal has been assumed whereas "E" might be used.

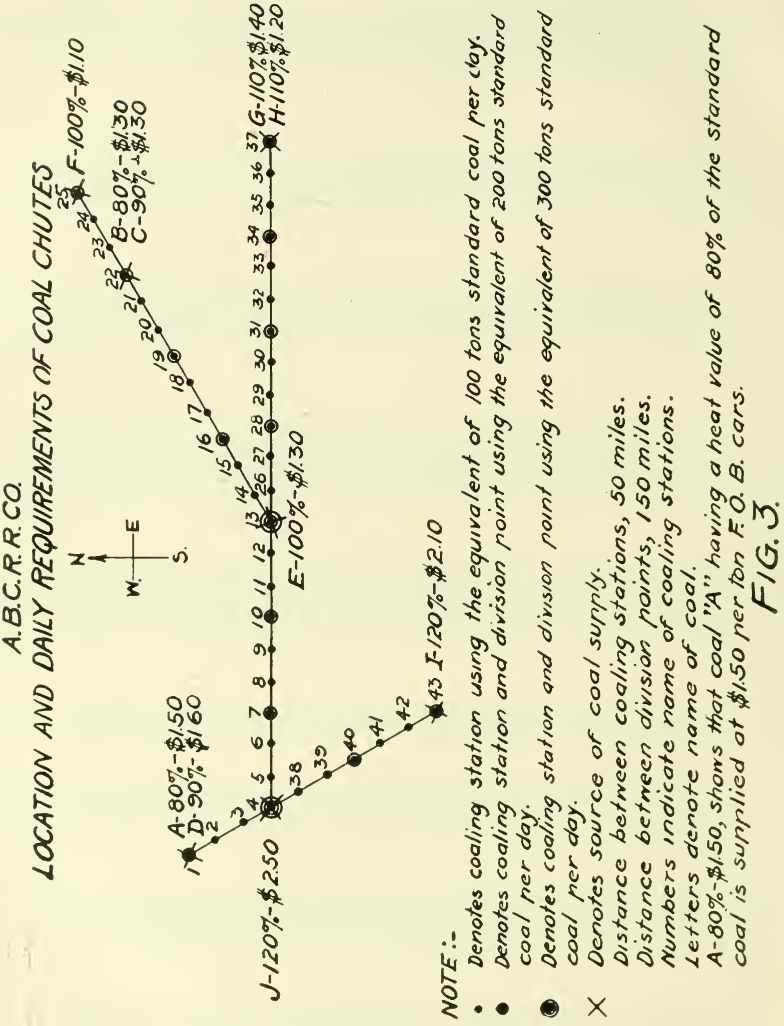

FIG. 3.

(5) Cost of haulage from source of supply to chute, two mills per ton mile. (Under the accounting system put in force by the Interstate Commerce Commission on July 1st no charge is made against the fuel account for the haulage of coal on a company's own line. This has been the practice, at least on the more important lines, for a number of years past; although about 1901 at least two of the important systems charged their fuel account with the haulage of company coal at the rates of three and five mills per ton mile, respectively. Whether or not the haulage of company coal

on a company's own line is, or is not, charged to the fuel account, is a matter of no importance, as the cost remains the same in either case, but in order to work out the best coal distribution it is a matter of the utmost importance to know accurately this cost of haulage. The above rate of two mills per ton mile is probably too low in most cases, but is selected at this figure to simplify the computations to follow).

COMPETITIVE POINTS.

The prices and heat values of the coals have been so selected that they illustrate a number of combinations that arise in practice which will be taken up under the following headings:

EQUAL HEAT VALUE, UNEQUAL PRICE AND SAME SOURCE OF SUPPLY.

Coals "G" and "H" having the same heat value, and being supplied from the same point should cost the same. As \$1.40 per ton is asked for "G" and \$1.20 for "H," "G" should not be used, and thus is eliminated from consideration.

EQUAL HEAT VALUES, UNEQUAL PRICE AND DIFFERENT SOURCES OF SUPPLY.

Coals "J" and "I," Fig. 4, have the same heat value, and "J" is supplied at \$2.50 per ton from station No. 4, 300 miles from station No. 43 where "I" is supplied at \$2.10 per ton.

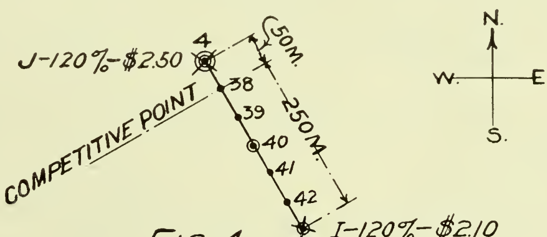

FIG. 4.

The dividing line between coals "J" and "I," which is called the competitive point, is found from the following equation in which "X" is the distance from station No. 4 to the competitive point.

$$\frac{\$2.50 + \$\ .10 + x\,(\$.002)}{120\%} = \frac{\$2.10 + \$\ .10 + (300 - x)\ \$.002}{120\%}$$

$$x = 50 \text{ miles}$$

This shows that at all points north of station No. 38 "J" coal should be used; south of station No. 38 "I" coal should be used, and at station No. 38 either "I" or "J" coal can be used, as both will cost \$2.70 on the engine at that point, made up as follows:

	Coal "J"	Coal "I"
F. O. B. Station	No. 4	No. 43.
First cost	$2.50	$2.10
Haulage	.10	.50
Handling at chute	.10	.10
Cost on engine, per ton	$2.70	$2.70
Cost on engine of amount equivalent to one ton of standard coal	$2.25	$2.25

Coals "E" and "F," Fig. 5 have also the same heat value and are from different sources of supply:

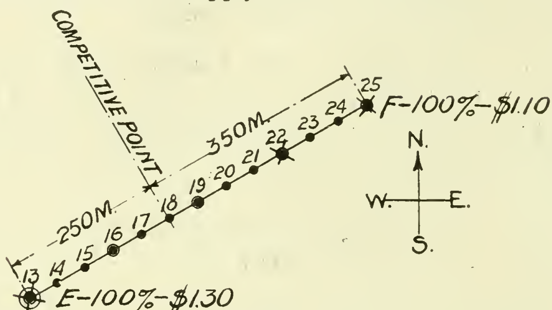

FIG. 5.

The equation for finding the competitive point of these coals is as follows:

$$\frac{\$1.30 + \$.10 + x(\$.002)}{100\%} = \frac{\$1.10 + \$.10 + (600 - x)\ \$.002}{100\%}$$

$$x = 250 \text{ miles}$$

This shows that at station No. 18 both coals cost the same, made up as follows:

	Coal "E"	Coal "F"
F. O. B. station	No. 13	No. 25.
First cost	$1.30	$1.10
Haulage	.50	.70
Handling	.10	.10
Cost on engine	$1.90	$1.90

UNEQUAL HEAT VALUES, EQUAL PRICE, SAME SOURCE OF SUPPLY.

Coals "B" and "C," costing the same, are supplied from the same source, but "B" is an 80 per cent and "C" a 90 per cent coal. As "C" is 12½ per cent better than "B," "C" should be used and "B" excluded.

UNEQUAL HEAT VALUES, UNEQUAL PRICES, SAME SOURCE OF SUPPLY.

Coals "A" and "D" are supplied from the same source, but are different in both heat value and price, "A" being an 80 per cent coal

costing \$1.50 per ton, and "D" being a 90 per cent coal costing \$1.60 per ton. "D" being 12½ per cent better than "A," and costing only 6 2/3 per cent more, should be used to the exclusion of "A."

UNEQUAL HEAT VALUES, UNEQUAL PRICES AND DIFFERENT SOURCES OF SUPPLY.

Coals "D" and "J," Fig. 6, are unequal in heat value and price and are supplied from different points. Their competitive point would be found as follows:

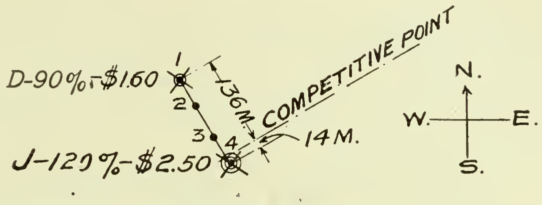

FIG. 6.

$$\frac{\$2.50 + \$.10 + x(\$.002)}{120\%} = \frac{\$1.60 + \$.10 + (150 - x)\ \$.002}{90\%}$$

$$x = 14.3 \text{ miles}$$

The competitive point of coals "D" and "J" is fourteen miles north of station No. 4, therefore chutes at stations No. 1, No. 2 and No. 3 should be supplied with "D," and station No. 4 with "J." At the competitive point coal on the engine would cost as follows:

	Coal "D"	Coal "J"
F. O. B. station	No. 1	No. 4.
First cost	\$1.60	\$2.50
Haulage	.27	.03
Handling	.10	.10
Cost on engine, per ton	\$1.97	\$2.63
Cost on engine of amount equivalent to one ton standard coal	\$2.19	\$2.19

The competitive point of coals "J" and "E,", Fig. 7, is found from the following equation:

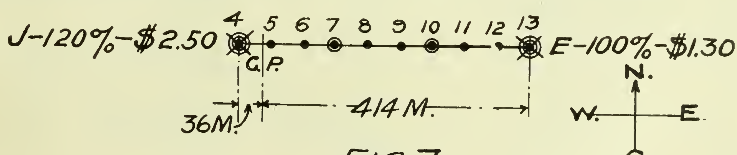

FIG. 7.

$$\frac{\$2.50 + \$.10 + x(\$.002)}{120\%} = \frac{\$1.30 + \$.10 + (450 - x)\ \$.002}{100\%}$$

$$x = 36.4 \text{ miles}$$

This shows that "J" coal cannot be used east of station No. 4 and that "E" coal should be used at stations No. 5 to No. 13 inclusive. At the competitive point coal on the engine would cost as follows:

	Coal "J"	Coal "E"
F. O. B. station	No. 4	No. 13.
First cost	$2.50	$1.30
Haulage	.07	.83
Handling	.10	.10
Cost on engine, per ton	$2.67	$2.23
Cost on engine of amount equivalent to one ton standard coal	$2.23	$2.23

The competitive point of coals "E" and "H" is determined by the following equation, as shown in Fig. 8.

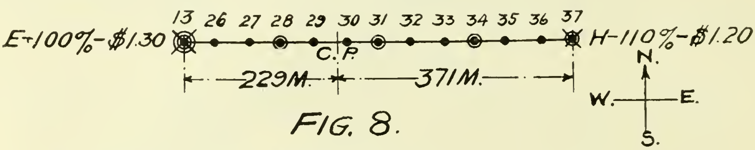

FIG. 8.

$$\frac{\$1.30 + \$\ .10 + x\ (\$.002)}{100\%} = \frac{\$1.20 + \$\ .10 + (600 - x)\ \$.002}{110\%}$$

$$x = 229 \text{ miles}$$

"E" coal is thus limited to station No. 29 and west thereof and "H" coal from stations No. 30 to No. 37 inclusive. At the competitive point the following would be the cost of coal on the engine:

	Coal "E"	Coal "H"
F. O. B. station	No. 13	No. 37.
First cost	$1.30	$1.20
Haulage	.46	.74
Handling	.10	.10
Cost on engine, per ton	$1.86	$2.04
Cost on engine of amount equivalent to one ton standard coal	$1.86	$1.86

The competitive point of coals "C" and "F," Fig. 9, is found from the following equation:

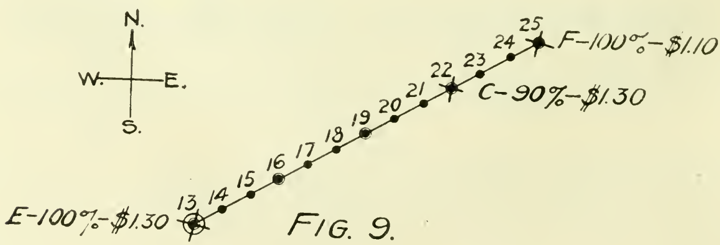

FIG. 9.

$$\frac{\$1.30 + \$.10 + x(\$.002)}{90\%} = \frac{\$1.10 + \$.10 + (150 - x)\$.002}{100\%}$$

$$x = -13.2$$

Note that "X" is a negative quantity which shows that "F" can be hauled 26.4 miles more than the above 150 miles and then cost the same on the engine at station No. 22, the point of distribution of "C," as the amount of "C" coal equivalent to one ton of standard coal. This is proven by the following table:

	Coal "C"	Coal "F"
F. O. B. station	No. 22	No. 25.
First cost	$1.30	$1.10
Haulage	.00	.30
Handling	.10	.10
Cost on engine	$1.40	$1.50
Cost on engine of amount equivalent to one ton standard coal	$1.55	$1.50

PRESENT VS. PROPOSED COAL DISTRIBUTION A. B. C. R. R.

The present coal distribution on the A. B. C. Railroad is shown by Fig. No. 10 and the proposed distribution by Fig. No. 11.

Some objection may be offered to the distribution shown in Fig. No. 10, but when it is considered that the relative heat values are not known before tests have been made the distribution is not an improbable one.

The cost of fuel per day under the present system of coal distribution is shown in Table No. 1 and that of the proposed distribution by Table No. 2.

The following totals, Table No. 3, made up from Tables No. 1 and No. 2, show the amount of each kind of coal used under the present and proposed distributions:

	PRESENT DISTRIBUTION		PROPOSED DISTRIBUTION	
Kind of Coal	Tons Used	Equivalent to Following Tons of Standard Coal	Tons Used	Equivalent to Following Tons of Standard Coal
"A"	875.0	700	.0	0
"B"	500.0	400	.0	0
"C"	555.5	500	.0	0
"D"	888.8	800	444.4	400
"E"	700.0	700	2300.0	2300
"F"	700.0	700	1100.0	1100
"G"	636.3	700	.0	0
"H"	636.3	700	999.9	1100
"I"	666.4	800	583.1	700
"J"	.0	0	333.3	400
Total	6158.3	6000	5760.7	6000

Table No. 3.

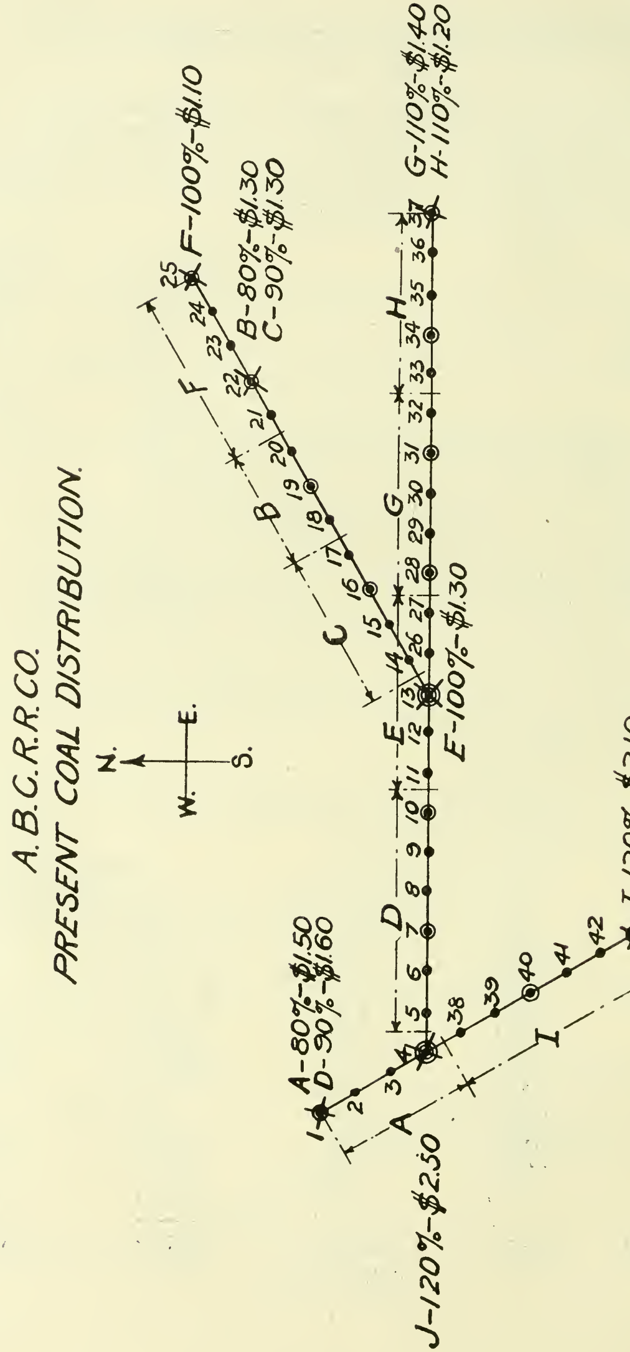
A.B.C.R.R.CO.
PRESENT COAL DISTRIBUTION.
N.
S.
E.
W.
F-100%-$1.10
B-80%-$1.30
C-90%-$1.30
G-110%-$1.40
H-110%-$1.20
E-100%-$1.30
A-80%-$1.50
D-90%-$1.60
J-120%-$2.50
I-120%-$2.10
A
B
C
D
E
F
G
H
I

FIG. 10.

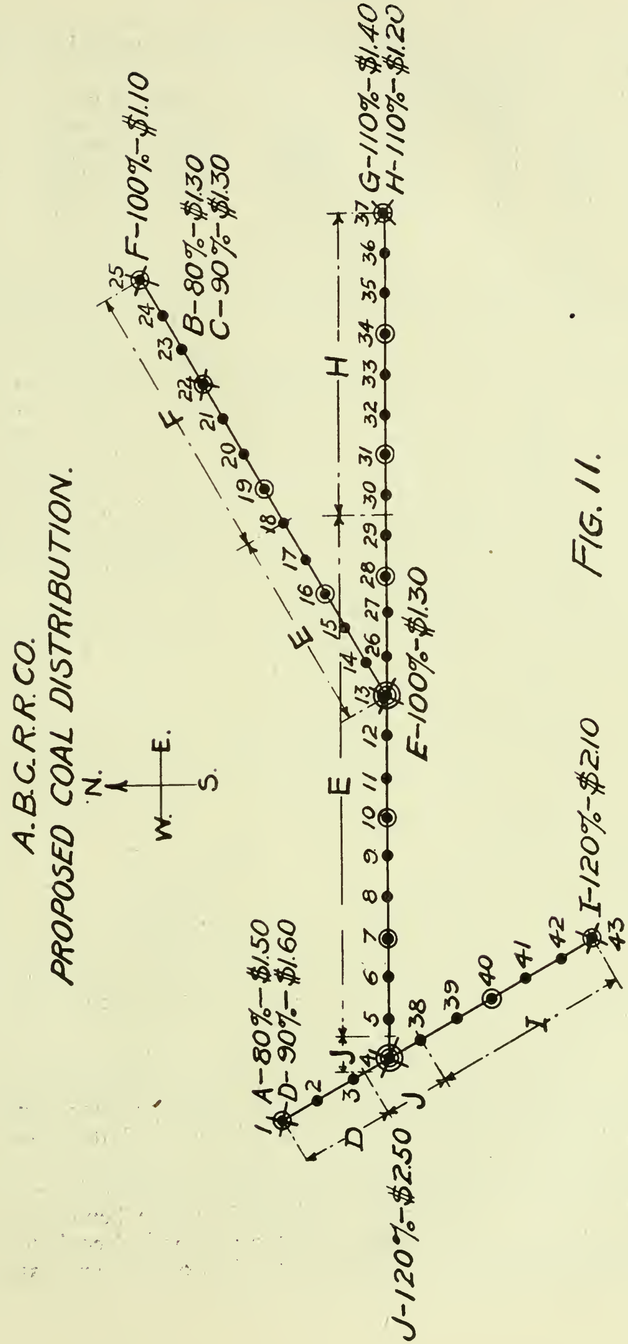
A.B.C.R.R.CO.
PROPOSED COAL DISTRIBUTION.
N.
E.
S.
W.
A-80%-$1.50
D-90%-$1.60
J-120%-$2.50
E-100%-$1.30
F-100%-$1.10
B-80%-$1.30
C-90%-$1.30
G-110%-$1.40
H-110%-$1.20
I-120%-$2.10
D
J
E
F
H
I

FIG. 11.

The following Table No. 4 shows the averages and totals of Tables Nos. 1 and 2, and shows the savings to be made by adopting the proposed distribution:

COAL		AVERAGE		COST OF COAL			
Distribution	Tons	Haulage	Ton Miles	First Cost	Haulage	Handling	Total
Present	6158.3	176	1,084,035	$8840.55	$2168.07	$615.83	$11,624.45
Proposed	5760.7	136	783,140	8058.68	1566.28	576.07	10,201.03
Difference	397.6	40	300,895	$ 781.87	$ 601.79	$ 39.76	$ 1,423.42

Table No. 4.

The proposed coal distribution would effect a daily saving of $1,423.42 on a daily expenditure of $11,624.45, or a saving of 12.2 per cent; $782 of the saving is due to the decreased amount paid mine companies; $602 due to saving in haulage, and $40 is saved by having less tons of coal to handle, there being only 5761 tons of coal used daily under the proposed distribution as against 6158 tons under the present distribution. The table also shows the decrease in the average length of haul and the decrease in total ton miles.

It is not expected that every railroad company in working out a coal distribution would find that there could be a saving of over 12 per cent made bv distributing the coal according to the methods herein outlined, but there is no doubt but what considerable saving is to be effected on most systems.

The relative importance of fuel and oil economy has often been mentioned, but by way of comparison it may be said that a saving of about two per cent in the fuel bill would pay for the entire amount of oil and waste used for locomotive lubrication, and many railroads can save several times the amount of the lubrication bill by perfecting their system of coal purchase and distribution.

During the last fiscal year the average cost of fuel for locomotives and lubrication for locomotives on several leading western roads was as follows:

Fuel for Locomotives..............	$6,042,266	13.2%
Lubrication for Locomotives........	148,160	.3%
Total Operating Expenses..........	45,604,823	100%

This shows that the cost of lubrication of locomotives amounts to only 2.5% of the cost of fuel for locomotives and that at least forty times the energy that is now spent in reducing the cost of lubrication should be expended on the fuel item.

It is not expected that any railroad can at all times distribute coal according to some predetermined plan, but the cost of fuel will be considerably less, when purchased and distributed according to its heat value and cost, than though purchased and distributed in a semi hap-hazard manner.

The greatest saving can probably be effected when the commercial demand is not at a maximum, which will prove beneficial to purchase and distribution by allowing more economical coals to be used and correspondingly less amounts of the less economical coals.

PRESIDENT SELEY: This paper presents the matter of fuel distribution on railways as a business proposition. The coal is weighed and valued and distributed in such a manner as to be most economical in cost when put on engine tenders. As a fuel department proposition the plan seems ideal. Whether or not traffic conditions and influence should be permitted to interfere with such a plan is perhaps open to discussion. The concrete example near the end of the paper is a fine exhibit of possible profit due to the adoption of business methods. The paper is now open to discussion. Prior to calling on the floor we have some written discussions that the Secretary will read.

THE SECRETARY: I have only two communications, one from Mr. Renshaw of the Illinois Central as follows:

CHICAGO, November 15, 1907.

Mr. Joseph W. Taylor, Secretary, Western Railway Club, 390 *Old Colony Bldg., Chicago.*

DEAR SIR: I have carefully read the pamphlet compiled by Mr. J. G. Crawford, Fuel Engineer of the C. B. & Q. R. R., and in my judgment it is a well and intelligent written article; if tests are made in line with his suggestions and recommendation, there is no doubt but what it will put the management of railroads in a position to decide intelligently the most economical fuel for use on its road, taking into consideration the cost of fuel, cost of hauling, and results obtained.

Yours truly,

W. RENSHAW,
Superintendent of Machinery.

THE SECRETARY: I also have a letter from the fuel agent of the St. Louis & San Francisco, Mr. Eugene McAuliffe.

ST. LOUIS, MO., Nov. 16, 1907.

Mr. Jos. W. Taylor, Secy., Western Railway Club, 390 *Old Colony Bldg., Chicago, Ill.*

DEAR SIR: I have your favor of the 13th inst., enclosing copy of the paper to be read at the Western Railway Club meeting on 19th inst., subject "Fuel cost as affected by heat value and distribution."

I regret that a previous and important appointment prevents my accepting your kind invitation.

I have read the advanced copy of Mr. Crawford's paper and believe that his theory and recommendations are such as would, if accepted and carried out, materially conduce to economies in fueling of railroads.

On the Frisco System we are distributing coal on practically the basis outlined by Mr. Crawford, taking into account first cost, evaporative efficiency, labor of handling at 8 cents per ton and haul at three mills per ton mile.

After making this distribution, which is revised from time to time, the efficiency of coals determined by actual locomotive test, we attempt in addition to take into consideration the difference in grade conditions as well as the direction of the prevailing light tonnage movement.

Respectfully,

EUGENE MCAULIFFE.

THE SECRETARY: Those are all the communications I have, Mr. President.

PRESIDENT SELEY: Mr. Bentley, will you open the discussion?

MR. H. T. BENTLEY (C. & N. W. RY.): Mr. President and Gentlemen: I have read the paper over several times, and I think that it has been very carefully worked out, and there is not a doubt about it that, from a purchasing agent's standpoint, it is probably the best that can be done. There are other things, however, to be taken into consideration, where we are operating engines over a piece of road as shown in Figure 7. For instance; we have 120 per cent coal at $2.50 at one end of the road, and 100 per cent coal at $1.30 at the other. According to the writer of this paper, the good coal would be hauled 36 miles and the poorer quality 414 miles. It is my opinion that it would be better to haul the 100 per cent coal the full distance, 450 miles, for the reason that we could then adjust the exhaust nozzle and front end to burn the coal more economically, otherwise when we came to burn the better quality coal with the smaller nozzle, it would be done at an increased cost per ton mile.

The trouble has been, with a good many roads, that the same quality of coal is not used at all points on the same Division. By doing so the engines could be adjusted to suit, and not have an engine with a small nozzle burning good coal and one with a large nozzle trying to burn poor coal. One minute the engine is popping and the next minute you can't get steam at all.

If we could know what kind of coal we were going to get we would fit our engines up for burning that kind of coal, and it would be very much more satisfactory all around.

We are rather differently situated from the majority of roads. We have mines in Illinois and Iowa, and our purchasing agent has just made an arrangement so that on the principal divisions we get either Illinois coal or Iowa coal entirely, and it has worked a wonderful revolution in the way our engines are performing; but when we were getting part Illinois and part Iowa coal on the same division, our engines would fall down on one section of the road and on the other section they would steam fairly well. There was another objection; the firemen were not capable of handling the coal to the best advantage; but, with the new distribution, which went into effect about 30 days ago, where the Illinois coal is used over a certain section and the Iowa coal is used over another section, we get better results.

I notice that something has been said about coals mixing with each other without additional trouble from clinkering. This is one of the greatest troubles we have; the clinkering of coal in fireboxes. I notice that the speaker has brought it up, so I wont enlarge upon it, but it is a very great objection.

I think the paper is well written and undoubtedly fits the conditions on the C. B. & Q. Ry.

MR. M. K. BARNUM (C. B. & Q. R. R.): I think the rather for-

midable array of figures may make some men feel that this plan is a little too theoretical for practical conditions, but I have studied the paper carefully and feel that it is well worthy of very careful consideration by anyone who is interested in fuel economy. I believe it is one of the most valuable contributions to our proceedings for a long time, and I know that the author has based his statements on a very thorough experience in doing just what he recommends in this paper, and doing it very successfully. He has outlined what may be considered the correct method of making coal tests. This ought not to deter those connected with smaller roads than the one where the author is employed from undertaking coal tests, for while he recommends that from four to eight men be used for making the tests, it is possible to make tests with less help which are well worth while. I have seen tests made by two or even one man which were of considerable value, although they could not be made with the fine accuracy of the tests described in the paper. The same suggestion will apply also to the amount of coal used and to the number of trips. It is desirable of course to make enough trips to get fair, average results, for, if you make only two trips with a certain kind of coal the conditions prevailing on one trip may give entirely different results from those on the other trip, and the object is to arrive at fair average results.

On the 6th page the author gives 2 mills per ton mile as the basis of his cost of haulage. I understand that the Harriman lines have adopted that figure as the actual cost to their companies for handling company material, and from investigations that I have made I believe it is fair and about right for the average railroad.

It seems to me that the most impressive part of this paper is the comparison of the expenditures for fuel and the possible savings with those for oil. We have all been educated and urged to save oil, and much has been accomplished in that direction, but while most roads have given some attention to fuel economy, I think very few have made the systematic and persistent effort to save fuel that most roads have to save oil, although the fuel bill is forty times as large as that for oil.

The principal objection, I think, which could be raised to the plan recommended by the author for distributing coal is the fluctuation of business and the conditions which prevail at times on every busy railroad that might tend to disarrange the programme, but the fact that the plan could not be carried out in every detail when business was heavy would be no valid excuse for not undertaking a plan and carrying it out as far as possible.

The advantages to be obtained from the ideal distribution advocated by the author seem to me: First, the reduction in cost of fuel, which has been shown to possess great possibilities; next, improvement in locomotive service which can be brought about by a careful distribution

of coal and avoiding the mixing of fuels which do not burn well together in the same engine. Another advantage is the increase in the mileage and consequently in the earning capacity of coal cars which will result from such a plan. These advantages together, are well worth the very careful consideration of every one connected with the distribution and use of coal.

President Seley: These are all bouquets so far, gentlemen. We want something on the other side to wake Mr. Crawford up. I would like to hear from some fuel department people.

Mr. D. C. Buell: Mr. President, the transportation people might raise some objection to a plan which seems to work out as ideally as Mr. Crawford has worked this one out from the purchasing agent's standpoint. Mr. Crawford shows a considerable saving in haulage based on ton mileage. I have not worked the figures out to find out whether this difference is due altogether to the lighter tonnage on account of the higher grade coal used, but it seems to me that there will be a great many times when possibly the grade line of the road is such that even with the low rate of two mills per ton mile shown there will be a difference in haulage cost to offset the difference in price of coal. The mines are sometimes located where it is not possible to gain the difference in the price of coal due to the heavy grade line over which the fuel would have to be hauled. There is another objection that the transportation people would raise, and that is as to the volume of business that the coal would have to travel with or travel against. In very many cases we find that conditions arise where the difference in moving loaded and empty cars is such that it would pay perhaps to haul coal further, (against the volume of business than on a short haul) where the haulage would be in the same direction with the volume of business, and I know of many cases where operating and car service conditions can be taken advantage of by the fuel agent if he will keep in touch with both departments. One case I call to mind at the present time is where a great number of empty gondola cars were required for pipe loading at a point where a good many cars of company coal were used. These cars were hauled into this district and stopped and loaded at mines at a considerable distance from the pipe loading point and hauled in loaded by other mines at a very little distance from the terminal where the pipe loading was done. In that way the empty foreign cars delivered from western roads and to be sent back empty to western points were utilized to supply that division point with coal and in that way relieved 20 or 30 system cars per day and left them in commercial service.

The theoretical idea of the paper I don't think can be improved upon. Mr. Crawford deserves congratulation on it. I do think, however, that in a consideration of this question the practical items of grade line, volume of business and car service should be considered, together with the ideal means of distribution.

President Seley: The paper is open to discussion, gentlemen. Anybody who has anything to say, either a member of the Club or a guest is welcome to speak. We would like particularly to hear from the fuel agents and purchasing agents who may be present.

Mr. H. H. Newsome (McCord & Co.): Mr. President, the point that Mr. Bentley brought up about the different grades of coal being used on one division I think is a splendid one, but it seems to me that two grades of coal can be used very conveniently. If a man starts out with a poor grade of coal and comes along to a point where he gets a good grade of coal, he is pretty apt to be able to use that on his poor fire. If he starts out with a good grade of coal and gets to where he has a poor grade his fire will probably be in good enough condition so that he can use the poor coal on the good fire.

President Seley: How about when he goes back?

H. H. Newsom: I refer to one grade of extra good coal and one of poor coal, the point being that good coal can be burned on a dirty fire and poor coal can be burned on a good fire. That is, starting out with the poor grade, when he comes to the good coal he can use it on a dirty fire or vice versa; if he has been using good coal he can use the poor coal on a clean fire, providing there are only the two grades of coal on the one division.

Then there was one gentleman who referred to a comparison between the cost of oil and the cost of coal. This is certainly a very important comparison but we must not lose sight of the fact that the cost of the oil is not all there is to that comparison. The work that is necessitated in the shop by poor lubrication is something that must be considered in making such comparison. I find there is no mention of this fact in the comparisons as made in Mr. Crawford's paper.

Mr. Wm. Forsyth (Railway Age): I have not studied the method of coal distribution here outlined, but I am quite interested in the statement relating to the heat value of coal, because I had occasion to prepare a paper for this Club a number of years ago on that subject and gave the heat value of most of the western coals, especially those on the Burlington as determined by the calorimeter and in that paper I expressed the hope that sometime we would be able to buy coal on its heat value, and I am glad to see that we have arrived at that time, as is shown by this paper.

At the last meeting of the Society for Testing Materials a number of papers were read by the Government people who are conducting coal tests or had made coal tests at St. Louis, and as the result of that work the Government has prepared coal specifications and is now buying coal to those specifications, especially for supply at Washington and they have worked it down to a sort of a basis where they pay one cent for 40 or 50 heat units, depending on the coal supply. The result of that has been that in competition for the

supply the coal miners have endeavored to improve the quality of their coal, and I should think that that would be one of the results of the work done by the Burlington Road. If that is done then it should call, I should think, for a revision of the figures which were given at one time for the value of coal at a certain mine, because if they are able to improve their method of preparing coal and produce better coal it ought to rank higher and bear a longer transportation. I was wondering if the result of this work had been to reduce the price of coal or whether the price of coal was still arbitrarily fixed by the coal dealers, and whether the amount bought would vary and the distance hauled would vary with the arbitrary price charged, or whether it had a tendency to equalize prices and bring about the purchase of coal based on its actual heat value. That, I should think would be the tendency when this method is used.

Mr. L. E. Endsley (Purdue University): The speaker has mentioned in his paper two different methods of determining the heating value of coal for locomotives, namely, the calorimeter test and the actual locomotive test. He has suggested that the actual locomotive test is of greater value than the calorimeter test. I would like to say in this connection that at Purdue we have found that the heating value of coal as determined in a calorimeter test is not in all cases the same as that obtained in an actual test upon a locomotive; that is, the coal which gave the best results under the calorimeter test did not always give the best results when fired in the locomotive. I have two coals in mind now—one, Pocahontas coal, the other Virginia lump coal. Under the calorimeter tests, the Pocahontas coal showed a higher heating value but in the locomotive tests, the reverse was true. This result was brought about by the excessive loss from cinders when firing Pocahontas coal, the loss being so great as to decrease its evaporative efficiency and therefore cause it to make a poorer showing. Moreover, the grate losses are not constant for different coals and this fact has its effect upon results obtained from a practical test of a locomotive. For these reasons, I agree with the speaker in saying that a locomotive test is of much more value than a calorimeter test.

Mr. W. E. Symons: Mr. President, Mr. Crawford has worked out a very nice arrangement for the distribution and handling of coal and he has received a number of very well deserved compliments, so I don't think it will be necessary for me to pass him an additional bouquet. Its application, however, to railway operation, as one might term it, contemplates a little higher degree of refinement than I think is practiced on very many roads, and probably will be acceptable to but very few. This, however, should not detract any from the value of the paper as an educational feature.

As has very properly been said by one of the previous speakers it opens up a line of thought in the direction of fuel economy and

fuel economy is worth all of the efforts which may be expended in that direction, regardless of whether the plan proposed is one suitable to every particular line of railway or not. Without detracting from the worth or value of the paper I am inclined to think that the plan would be rejected by more roads than it would be accepted by, but the spirit of it would not, or at least should not, be rejected by any railway company, no matter where they are located or under what circumstances. It is a fact, however, that a majority of coal used on railways is bought, as you might say, like a pig in a poke, and in many instances they don't even take the pains to take the pig out of the poke and look at it. It is just simply delivered, burned and a call made for more. This has resulted from various causes and conditions. As a rule railway companies are closely allied with coal mining companies. They are both closely allied with the industrial progress of the country and it is not infrequently the case that a quality of coal that is not marketable at remunerative or inviting prices can be used by the railway company and therefore it falls into their hands, and is delivered to the Motive Power officers to use, where there is much better coal produced in the same locality with greater steam heating qualities that is sold. I am inclined to think that assuming a pound of bituminous coal has 14,000 B. T. U., the average ton of coal used on a locomotive has no more than 10,000 B. T. U. Therefore, we are paying for about 40 per cent more heat value than we get. If, however, the plan proposed by Mr. Crawford is put into effect, and on which the savings are predicated, which he has quoted, I am inclined to believe that coal would go up to a corresponding price, because the very moment you force the coal dealers to give you heat units instead of tons that means a better grade of coal, it means a grade of coal that they are now selling commercially at prices much more than the difference shown in the relative value of the coals.

I would like to ask the author if he would, in his closing remarks, give us a little information on the matter of depreciation of fuel exposed to the elements, particularly where it is not housed in. As I understand it, the exposure of coal to the elements is in reality a slow process of combustion, and as it is sometimes purchased on lines similar to that outlined by the author and hauled to certain points and kept there for future use, it follows that if kept for a considerable length of time the probabilities are that it would depreciate some in value, and with his wide range of experience I feel quite sure that he can give us some valuable information on that subject.

The matter of hauling coals which has been referred to by a previous speaker and also by Mr. McAuliffe, I think that should be considered and doubtless will be in connection with general conditions. Mr. McAuliffe's road lies in a country abounding with coal

mines where they have at times much difficulty in selling their product, and they are very solicitous about furnishing his line with coal. That, together with the fact that Mr. McAuliffe is one of the best coal experts in the country, and has rather unusual powers in the purchase and distribution of coal, results in his employing company having all the advantages that come from those various favorable factors, and a result or condition that might be working smoothly on his line of road or possibly on the C. B. & Q. R. R. might not be so successful on other lines, or in countries where it is a question of getting a carload of any kind of coal under any kind of circumstances. The plan, of course, would have to be subordinated to the conditions.

I would also be glad to have the author, if he would kindly do so give us the benefit of his views as to his method of keeping a check on the change in the quality of coal that may come from a different vein in the same mine so graded, and which frequently changes very materially in value, although it comes from the same mine and is sold under the same grade or quality.

I would also like to ask one more question of the author; does he consider that of the general average fuel, furnished railway companies we could safely assume that the coal E, which is 100 per cent, would give an evaporation of 7 pounds of water per pound of fuel?

Mr. D. C. Buell: May I have the floor for a moment, Mr. Seley. I was quite surprised at what was said by Mr. Endsley about the difference between theory and practice. I have had experience firing Pocahontas coal, and as you know it is a hard coal to handle unless it is handled just exactly right on a locomotive. I wanted to ask if every precaution had been taken which could be made in preparing those tests, in changing the draft of the engine and educating the fireman so that he could get the results from Pocahontas coal that surely ought to be obtained and are obtained in practice.

I have known of cases where during fuel shortages on roads in Ohio and in our part of the country a very poor class of coal which they had been using was followed up by Pocahontas coal which the firemen did not know how to handle at all and which engines were not drafted to burn, and with the finest steam coal in the world they had repeated engine failures. The firemen didn't know how to burn it, but after they had had the engines changed and the firemen learned to use it they had to give up their Pocahontas coal and go back to their dirt and slate they were a sorry set of men. It always seems to me that theory and practice should agree.

Mr. Endsley: In answer to Mr. Buell's question, I would say that we have had but little trouble in firing Pocahontas coal and at light power tests, we have been able to obtain with that coal an equivalent evaporation of nine pounds. At heavy power tests, however, this value was reduced to some extent, the difference being that

the loss in heat from cinders was sometimes as high as twenty per cent of the total heating value of the coal.

Mr. J. F. DeVoy (C. M. & St. P. Ry.): Inasmuch as the author has distinctly stated that the purpose of this paper is not to discuss the economical use of coal on locomotives I suppose that we are barred out. I sat still until I thought it was about time that there was a little disturbance started. In starting that disturabance I want to say to you in answering the last speaker that any man who can evaporate nine pounds of water per pound of coal has done more than has yet been done in the United States, and I quote as my authority Professor Breckinridge, of the University of Illinois, in a paper before the Society of Engineers in Milwaukee, in which he stated that they had not been successful, and I haven't the slightest idea but what it has not been done.

In the past five years it has been my privilege to make a locomotive test of coal as suggested by the author of this paper, with the exception that instead of testing on a passenger train we used one freight engine for all the tests and for all the coal. The best results that I have seen from western coal, that is, Illinois coal or Iowa coal, was from 5.5 to the highest 6.2 pounds of water per pound of coal.

The statement made by another speaker to-night that coal shall be purchased on its heating properties never has been accomplished and never will be, for the reason that among the five different kinds of Central Illinois coal there will be a difference of from 8 to 10 per cent in the heating value of the coal, and there will be from 8 to 10 per cent loss in the same coal, due to the amount of foreign matter in the coal. The first thing against any coal is the amount of ash that it contains. The next thing, and the easiest thing to burn, is the fixed carbon. Any engine will burn coal, and without any great amount of preparation, which contains a large percentage of fixed carbon. The most difficult thing to my mind is the amount of volatile matter or the length of the flame or the amount of smoke that must be burned, and I must ask pardon of the audience if I get a little away from the transportation problem and get down again to the boiler. It as an absolute impossibility to burn Illinois coal to-day in a boiler that is used in say New York state where anthracite coal is burned, for the reason that the distance between the grate and the flue is not of sufficient length unless protected by a brick arch, and there is no method better than a brick arch to burn the gases. I may be getting a little bit too far away, but let me say to you a word or two about what I think of it. The amount of coal in the United States is fixed. If you place a map of the United States on the wall you will find the greatest amount, according to my recollection now, about in central Illinois, or a section bounded by a few states there. There is in the state of Iowa a good coal, but

hard to mine, and the mines there flood easily. You go further west and there is a good supply. The coal in West Virginia is one of the best in the country and ranks among the highest, so that along with the forest preserves of the United States the coal preserve is well defined and the coal must be obtained from those points, and any criticism of mining men for obtaining it from those points is wrong, absolutely regardless of how far you have to transport the coal. I realize, and so do you, gentlemen, that the idea of transportation which is given us to-night is one of the best, but still the point of production must first be considered; also the cost of mining the coal. And above all that, the greatest thing to-day in American railroading is the fact that a boiler has not yet been designed to burn the coal as it should be, in locomotive practice.

I don't wish to be understood as criticising this paper. It is a splendid paper, but there are a great many things that enter into this subject that must be considered, and while the author is to be complimented on the paper still my object now is not to get back at the author, but to get back at the statements made by a few of the members, which I know to be absolutely untrue. (Laughter and applause.)

Mr. Endsley: Mr. President, may I answer that? An equivalent evaporation of nine pounds of water per pound of coal is not excessive when testing Pocahontas coal. If Mr. De Voy does not believe that this is so, I would like to test especially for him. The Purdue locomotive has demonstrated this a number of times, when using Pocahontas coal. It would no doubt be excessive for an Indiana or Illinois coal, these coals possessing a much lower heating value, but, as I have said, for Pocahontas coal, this value is not excessive.

Mr. DeVoy: Mr. President, pardon me. May I have just a moment? The gentlemen should go home to-night and get Professor Breckinridge's paper and read it. He says to the locomotive builders of the United States: "I haven't the slightest idea that the locomotive boiler as designed to-day is the proper way to burn coal." In other words, the boiler builders must do the same thing that the engine builders have done for steam; instead of putting in apparatus that would cost ten times the amount of money that a stationary plant does we must get our rapid circulation in a locomotive boiler to-day by the proper method. He said that he would be criticised. He said that Professor William Kent would be one of the first to criticise him. He said that the gentlemen to my right would be one of the men to criticize him in that, but those statements were made, and I want to tell you right here that if I have to walk to your home I will go down to your place at any time to see that nine pounds of water per pound of coal evaporated in a locomotive boiler.

Mr. Paul R. Brooks: Mr. President, the paper is so complete that it leaves very little of the real subject to discuss. The remark

about the relative amounts involved in the oil and coal saving was probably an afterthought but it seems to have attracted a good deal of attention. Mr. Bentley's point is very well taken regarding the uniformity of fuel throughout one Division, because the fireman has not reached a mental state of development where he can handle any coal to its best advantage. That will be the next question in line to study. This study of Mr. Crawford's is the starting point or the fundamental basis upon which to base all estimates of saving coal. It is incomprehensible to me to understand why railway managements, why the able and brainy men who have been at the head of railways for many years have been so slow to get right out on the road and insist that the mechanical department spend a much larger portion of its energy towards cutting down the coal bills; to compel them to get it done, to give it their personal attention. Considering the fact, gentlemen, that the coal is such an enormous item of expenditure in the operation of a railroad. The next thing we want to know is how to go ahead and apply this plan of study and save coal on engines and at the roundhouses. In connection with this I am reminded of a little story. I trust it won't tread upon the toes of any gentleman present, but on a railroad not very far from here, there was the question of oil saving originated at the top. By the time it got out on the road in the mechanical department, it came in the form of a recommendation to see why they could not try such and such an arrangement (I forget whether it was a device or a brand of oil), to see if they could not cut down the oil bills. The local officials were disinclined to believe that their methods could be improved: They took the position they were doing the best thing possible. There were two engines picked out of the group on which to try the new scheme and they were to be tried against six of the engines in the pool. Of course local pride kept the six to very satisfactory point. When the tests were finished at the end of six months the six engines were neck and neck with the two with the improved fittings; but the local lights were set gasping for breath when the next question of the general manager came; he wanted to know why all the rest of the engines in the pool showed up so much worse than those six, the general average.

President Seley: Well, Mr. Crawford, will you close the discussion?

Mr. J. G. Crawford: First, answering Mr. Symon's question as to whether or not coal "E" has too high a heat value for a standard coal. Coal "E"' assumed as an 100% coal, will evaporate the equivalent of 7.00 pounds of water from and at 212 degrees, per pound of coal as fired. Under ordinary conditions of feed water temperature and steam pressure this coal would evaporate about six pounds of water per pound of coal as fired; hence this coal would not differ greatly from many Illinois coals.

Aside from the fact that results will be more clearly understood if the standard (100%) coal represents the average coal on the railroad system, it makes no difference in the results or computations what coal is taken as the standard; it might be the best or even the poorest.

Now, as to the paper being too theoretical and seeking to accomplish something which could not be attained. The point is just this: It is something that has been said before so many times that it is hardly worth repeating, but the point is to have a definite aim and go for it. If there is not some definite aim in your coal distribution or in your coal purchase you never get anywhere near the point that you should reach; and, whereas, these two different coal distributions show a difference in economy of 12 per cent, I do not for a minute believe any railroad would ever find a 12 per cent saving on this basis, certainly not for a number of years, because it takes a long time to get any system into operation, but if you can get a one per cent saving or a half of one per cent saving it is worth going after. For instance, on our road the fuel bill amounts, considering the haulage at 2 mills per ton mile, to about $8,000,000 per year. One per cent of that $8,000,000 or half a per cent, is an amount worth saving.

Answering Mr. Buell's question, whether in the case of the A. B. C. R. R. the proposed distribution gives a decrease in ton miles due solely to a decrease in tons. By referring to Table No. 4 you will note that this decrease in ton miles was due to the tonnage decreasing from 6158 to 5761, and also to the fact that the average length of haul dropped from 176 miles to 136 miles.

One question I recall now was, how to keep track of the quality of coal from a certain mine and see whether it is changing from time to time. That can be handled very nicely by coal inspectors in most cases, and after a time if there is any reason to suspect that the quality of coal has changed materially that coal should be retested. I know of one case where an 8-foot vein was worked to a certain point, at which point the vein divided in two parts, there being about four feet of coal above and below a couple of feet of rock. The coal inspector reported this case immediately. Laboratory calorimeter tests will serve to keep check on the calorimeter heat value of the coal and are thus useful. Such tests do not, as stated previously, necessarily indicate its value in a locomotive.

In regard to using more than one kind of coal on one engine division. That would not be recommended unless, of course, the coals would mix with one another, without additional trouble from clinkering, etc. (The word "etc." you notice I put in when reading the paper. It was in the original, but was left out in printing.) No one would want to see an engine drafted so that it would burn a poor steaming coal and then pick up a good steaming coal and throw

half of it out of the stack. This condition or any other tending to increase trouble with engines steaming would not be advocated. Economies as outlined in this paper can often be effected without the Mechanical Department even knowing that any change in coal distribution has been made.

As to results of tests of storage coal. There have been some tests outlined which are now on the books and have never been made, but will be made probably in the course of the next year or two. These tests contemplate testing a number of coals and then put some of each on the ground and store them for six months, at the end of which time they will be re-tested and also re-tested at the end of a year. In that way we will get somewhere near the loss per month due from storage in weight and heat value per ton of original coal. The amount of storage coal used is a comparatively small amount of the total coal used by a railroad system, and it becomes of still smaller importance when you consider the number of months which that coal is stored. These tests will be left to the last and the points of greatest saving looked after first.

Of course on a railroad the size of the Burlington the tests can be completed in a short time. The organization is such that it can be handled in that way, but on a smaller road one or two men can handle coal tests as already stated by Mr. Barnum. Where a number of coals are to be tested on one division, the testing force should be large enough so that tests of one coal can be finished in about eight days. This is desirable in order that the flues may be in practically the same condition at the beginning and end of the series of tests. That is, not tests of just one coal, but a series of tests of eight or ten coals. Also, if a series of tests extend over too long a period there may be several changes in firemen, due to promotion or other causes. Where this does occur it is necessary to duplicate tests of one or two coals in order that the relative efficiency of the firemen may be established.

There are oftentimes objections raised to tests on passenger trains. It is sometimes stated that the trains will be delayed, but there is no occasion to delay any train on account of a coal test. It is also said that as long as the larger percentage of the coal is used for freight service the coal should be tested in freight service. In order to get results quickly coal should be tested in passenger service. The difference in comparative evaporative efficiency of coals used in passenger and freight service, if any, is very slight, and is more than offset by the fact that tests of coals made in passenger service can be completed in from one-third to one-half the time that would be required in freight service. The larger economies will be shown by passenger tests and freight tests might show some additional, though smaller economies; but as the larger economies should be effected first, tests should be made in as short a time as possible and consequently in passenger service.

Now in regard to laboratory calorimeter tests as compared with engine tests. I thought that question might come up so I brought some figures. The calorimeter determinations of the heat values of coals will give their comparative heat value in a locomotive, providing the coals are nearly alike, but the calorimeter heat values will not be comparative for coals differing by 20% or 30%. I have here three coals which are called X, Y and Z. They rank as follows:

Name of Coal	Rank by Locomotive Test	Rank by Calorimeter Test
X	100.0%	100.0%
Y	67.0%	77.7%
Z	66.0%	75.2%

It shows that there evidently was a lot of coals Y and Z going out of the stack and those losses would not be shown by the calorimeter test.

There is another feature which shows the desirability of making tests on locomotives, rather than in the laboratory calorimeter, and that is, that purchasing agents and operating officers will have more confidence in results of coal tests on locomotives made with from 200 tons to 300 tons of coal than they will on laboratory calorimeter tests based on the results of from 6 to 20 one gram samples obtained from 300 or 400 pounds of coal.

There was a point brought up that coal tests might have the effect of increasing the price of coal. Now, I cannot believe that there would be any more tendency to increase the price of coal, than there has been to increase the price of boiler steel, rails, lumber, cement or any of those commodities which are bought under specification or inspection. The coal companies do not know the results of these tests. They are for the use of the officials of the road and they never reach the coal companies. In this respect the purchasing agent is in better position to make economical contracts, than in the case of the U. S. Treasury Department, cited by Mr. Forsyth, where the consumer's idea of the heat value of the coal is known to the coal company.

The matter of traffic conditions, such as grade, light tonnage, direction of volume of business, etc., have been brought up. Now they can be covered by the haulage rate per ton mile. There is for any of the above or other cases a certain rate; it may be two mills; it may be five mills; it may be six or eight mills; but whatever the conditions are, there is always a corresponding rate and the rate should be so determined as to take care of those conditions. I can see no reason in any case for taking the rate on company coal higher than your commercial rate, in figuring your coal distribution under normal conditions or a temporary distribution under abnormal conditions.

There are many traffic conditions which will arise that will tend to make any predetermined coal distribution uneconomical for a

STEAM PRESSURES
WATER WASTES
SHUT-OFFS
STOPS
WATER
COAL
GENERAL

Form 4164. Y. 2 01 1M

____ M.	____ M.	____ M.
00	00	00
10	10	10
20	20	20
30	30	30
40	40	40
50	50	50
00	00	00
10	10	10
20	20	20
30	30	30
40	40	40
50	50	50
00	00	00
10	10	10
20	20	20
30	30	30
40	40	40
50	50	50

	OBSERVED	CORRECTED	ABSOLUTE
AVERAGE	#	#	#
MAXIMUM	#	#	
MINIMUM	#	#	

STEAM PRESSURES

WATER WASTES

INJECTORS	LOSS PER APPLICATION	No. OF APPLICATIONS	TOTAL WASTES
RIGHT	#		#
LEFT	#		#

LEAKAGES	RATE PER MINUTE	No. OF MINUTES	
TANK HOSE	#		#
" "	#		#
TANK	#		#
"	#		#
MUD RING	#		#
" "	#		#

HOT BEARINGS			
	#		#
	#		#

OTHER WASTES			
	#		#
	#		#

TOTAL WASTES #

RECORD OF INJECTOR APPLICATIONS

RIGHT

LEFT

WATER WASTES

SHUT-OFFS

PLACE	MINUTES	REMARKS

TIME IN MOTION ____ HRS. ____ MIN.
" " SHUT-OFF ____ HRS. ____ MIN.
" " USING STEAM ____ HRS. ____ MIN.

SHUT-OFFS

STOPS

PLACE	ARV.	LV.	LENGTH OF STOP	REMARKS

TIME ON ROAD ____ HRS. ____ MIN.
" OF STOPS ____ HRS. ____ MIN.
" IN MOTION ____ HRS. ____ MIN.
NO. OF STOPS ____

STOPS

WATER RECORD

PLACE	TEMP.	INCHES	WT. LBS.	AMT. DRAWN

AVERAGE ____°

TOTAL - - - - - - - - ____ #

CORRECTIONS

WATER WASTED ____ #

WATER IN GAUGE GLASS ____ #

TOTAL - - - - - - ____ #

WATER APPARENTLY EVAPORATED ____ #

NOTE: WATER AT END OF RUN WAS ____ INCHES { HIGHER / LOWER } IN GLASS THAN AT START.

WATER

WEIGHT OF TENDER

AT START (AT SCALES)
LOADED ____ #
EMPTY ____ #
(A) IN PIT AT START ____ #

AT FINISH (AT SCALES)
LOADED ____ #
EMPTY ____ #
(B) IN PIT AT FINISH ____ #

CHARGE TO TRIP

(A) MINUS (B) ____ #
SACKED COAL ____ #
LOOSE COAL AHEAD OF GATE ____ #
CORRECTION ACCOUNT OF WATER LEAKING FROM TANK BETWEEN "EMPTY" AND "LOADED" WEIGHINGS AT START ____ #
TOTAL CHARGES ____ #

CREDIT TO TRIP

COAL USED FROM PIT BEFORE STARTING ____ #
COAL SAMPLE ____ #
COAL FELL OFF TENDER ____ #
COAL USED FROM PIT AFTER ARRIVING AT DEPOT AND BEFORE WEIGHING ____ #
CORRECTION ACCOUNT OF WATER LEAKING FROM TANK BETWEEN "LOADED" AND "EMPTY" WEIGHINGS AT FINISH ____ #
TOTAL CREDITS ____ #

NET COAL USED ____ #

LEAKAGE OF WATER BETWEEN WEIGHINGS

	EMPTY	LOADED	TANK LEAKAGE PER MINUTE
START			
FINISH			

NOTES: SACKS WEIGH ____ # EACH
IN ESTIMATES USE WEIGHT OF A SHOVEL-FULL ____ #
FIRE HAD ABOUT ____ # MORE / LESS COAL AT FINISH THAN AT START
COAL FROM CAR ____ KIND ____

COAL

TRAIN ____ ENGINE ____ DATE ____
ENGINEER ____ FIREMAN ____

CARS

NUMBER	FROM	TO

WEATHER

	START	FINISH	AVERAGE
TEMPERATURE OF AIR			
BAROMETER—INCHES			
" —POUNDS			

RAIN OR SNOW

FROM	TO	HEAVY OR LIGHT

MISCELLANEOUS

ASH PAN DUMPED	FIRE CLEANED	GRATES SHAKEN

HAS ENGINE A BRICK ARCH? ____
SIZE OF EXHAUST TIP? ____
COAL SAMPLE IN CAN # ____ TO ENG R TESTS

REPORT OF COAL SACKS

	LOADED	EMPTY	TOTAL
ON ENGINE AT START			
" " " FINISH			
ON HAND AT N. or E. TERM			
" " " W. or S. "			

	PLACE	SIGNATURE
COAL WEIGHER		
" "		
ENGINE RIDER		

Form 4164. GENERAL Y. 2 01 1M

FIG. #1

ITEM	TEST NUMBER			AVERAGE	EXPLANATIONS
1	TRAIN				
2	DATE				
3	ENGINE				
4	ENGINEER				
5	FIREMAN				
6	WEATHER		Rain		
7			Temperature		
8	ACTUAL TIME TABLE		Leave or Arrive		
9			Arrive or Leave		
10	TIME		On road		
11			Of stops		
12			In motion		Item 10 – Item 11
13			Shut off while in motion		
14			Using steam		Item 12 – Item 13
15	NUMBER OF STOPS				
16	" " CARS				
17	AV. SPEED M.P.H.		In motion		÷ Item 12
19			Between terminals		÷ Item 10
19	BOILER PRESSURE WHILE USING STEAM		Average		
20			Minimum		
21	FACTOR OF EVAPORATION, QUALITY ASSUMED 98.5 %				$\frac{q+xr-h}{965.8}$ (See Kent)
22	COAL	ANALYSIS	Moisture %		
28			Volatile Matter %		
28			Fixed Carbon %		
25			Ash %		
28			Sulphur %		
27			British Thermal Units by Parr Calorimeter		
28		CONSUMPTION ACTUAL	Total		
29			Per hour		Item 28 ÷ Item 14
30			" " per sq. ft. of G. S.		Item 29 ÷ Grate surface
31	WATER		Apparently evaporated		Water entering boiler
32			Equivalent Evaporation, from and at 212°		Item 31 × Item 21
33			Temperature		Thermometer in manhole
34	EVAPORATION	PER POUND OF COAL, ACTUAL	Apparent		Item 31 ÷ Item 28
35			Equivalent		" 32 ÷ " 28
36		RATE PER HR.	APPARENT		" 31 ÷ " 14
37			EQUIVALENT Total		" 32 ÷ " 14
38			EQUIVALENT Per sq. ft. H. S. (Inside Flues)		" 37 ÷ Heating surface
39	COMMERCIAL BOILER HORSEPOWER				" 37 ÷ 34.5

17 COLUMNS BETWEEN ARROW POINTS FOR TEST RECORDS

LESS IMPORTANT AVERAGE RESULTS

COAL	CON-SUMPTION	TOTAL	Dry	
			Combustible	
		PER HR.	Dry	
			Combustible	
EVAPORATION	APPAR-ENT	PER LB. COAL	Dry	
			Combustible	
	EQUIVA-LENT		Dry	
			Combustible	
			Actual, by Parr Calorimeter	
Heating surface per Boiler H.P.				
Boiler efficiency				

ENGINE DATA

Engine number		
" class		
Heating surface, inside flues		
Grate "		
Exhaust tip, diameter		
" ", bridge		

HELPER USED

TEST	FROM	TO

KIND OF COAL

Name	
State	
County	
Town	
Mine	
Grade	
Mined by	
Purchased of	
Tested between	

C. B. & Q. R. R. Co.

OFFICE FUEL ENGINEER

COAL TESTS

CHICAGO, ILL.

NO.

Fig. 2.

short period on account of some haulage rate increasing; on the other hand there will be cases where the traffic conditions will tend to lower the established haulage rate. Thus, the advantage of the fuel department keeping in touch with the car and traffic situations as mentioned by one of the speakers.

For normal conditions the haulage rate should be accurately determined, and the most accurate determination of this cost would include separate rates from each mine or point of supply to each coal chute and in many cases this would involve the use of different east and west bound rates over the same division. In some cases these refinements might be warranted. In any event the rate should be figured about as follows:

A railroad is hauling 10,000,000 ton miles per day of which 1,000,000 ton miles are company coal and conditions change so that 1,200,000 ton miles company coal are hauled or a total for all freight of 10,200,000 ton miles. The rate per ton mile for hauling company coal should then be figured as the difference in operating expenses for 10,200,000 ton miles, and the operating expenses for 10,000,000 ton miles, divided by 200,000 ton miles. This method will avoid charging the haulage of coal with operating expenses which would not be affected by an increase or decrease of ton mileage of a company coal.

The enormous cost of haulage of company coal is not as a rule fully appreciated. Company material amounts to about 10% of the total traffic of a railroad and the majority of this company material is coal. The importance of keeping the ton mileage of company material and especially coal to a minimum is thus seen. This can best be accomplished by knowing what the haulage of company material is costing and the most elaborate method of determining this would necessitate each shipment of company material to be billed at a rate representing the cost of haulage. In the case of coal the above results can be accomplished in a simple manner; thus—

Each coaling station can arrange to keep record on a suitable form of a number of tons of each kind of coal used each month. This blank will then be forwarded to headquarters and the cost of haulage and handling inserted. This blank then gives a complete cost of the coal for each coaling station for each month and this cost is subdivided between first cost, haulage and handling. A summary of these blanks and comparison from month to month will soon show where improvement is to be made.

Mr. Symons has referred to the close relations existing between coal companies and railway companies and to the fact that oftentimes railway companies take considerable quantities of coal not marketable at remunerative prices. If for any reason a certain coal company or group of coal companies must be favored it is advisable for both the traffic and operating departments to know what it costs

to favor those companies. Probably the most equitable method would be to credit this cost of favoritism to "Engine Service" and to charge this to "Traffic Department Expenses." Of course, this method of credit and charge would not be acceptable but even if not actually charged and credited to the operating accounts the cost of favoritism should be known to the operating and traffic officers.

If it costs $50,000 per year to favor the Blue Diamond Coal Company and the railroad does not get $50,000 benefit from that favoritism then the favoritism should be cut to a paying basis. I thank you, gentlemen.

Mr. W. E. Symons: I am very sorry to learn from my friend DeVoy this evening that Mr. Crawford and myself will not be able to go into the coal business on a heat unit basis, but, notwithstanding that, I wish to give additional indorsement to the thought evidenced by his paper and also to the gentleman himself by moving a vote of thanks.

Mr. DeVoy: I second that.

Motion carried unanimously.

President Seley: Before entertaining a motion for adjournment I would like to say just a word or two in regard to our discussion. It is always more entertaining and lively to have a general discussion and I would like to see the younger men of the Club come forward, as some of them have to-night, and take active part. There is no training that is as good for a young man in business, for his future comfort, even, as to be able to get on his feet and talk, even though he cannot be sure of what he is going to say next. The oftener he tries it the surer he will be, and I hope that as the season progresses and we have other papers from time to time that you will get hold of them in advance and study them up and not be afraid to undertake discussion. We want the Western Railway Club to be of the utmost value to everybody, and I don't know of any more value that it can be to the younger element in the Club than to give them an opportunity to debate. A motion to adjourn will now be in order.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, December 17, 1907. President C. A. Seley in the chair. The meeting was called to order by the President at 8 P. M. The following members registered:

Albert, C. J.
Ames, C. F.
Angell, F. R.
Ayers, A. R.
Axtell, G. F.
Baker, F. L.
Barnes, C. A.
Barbee, D. C.
Barber, L. W.
Barnum, M. K.
Basford, G. M.
Bentley, H. T.
Blatchford, Carter
Boardman, W. H.
Borrowdale, J. M.
Bower, J. G.
Brown, S. D.
Callahan, J. P.
Cardwell, J. R.
Carlton, L. M.
Carney, J. A.
Chadwick, A. B.
Christenson, A.
Clark, F. H.
Clingman, C. S.
Cooke, G. T.
Cooley R. P.
Cota, A. J.
Crane, R. T.
Cram, T. B.
Cunningham, J. B.
Damon, G. A.
Derby, W. A.
DeVoy, J. F.
Dewey, L. R.
Endsley, L. E.
Ensign, H. W.
Fenn, F. D.
Flavin, J. T.
Flory, B. P.
Fogg, J. W.
Forsyth, Wm.
Fosdick, F. C.
Fry, C. H.
Furry, W. S.
Gale, W. T.
Garland, T. H.
Gennet, Jr. C. W
Gilmore, F. M.
Graves, F. W.
Hahn, F. W.
Hamilton, J. R.
Hammond, Jr. W. S.
Hibbard, M. W.
Higgins, C. C.
Hildreth, F. F.
Hinds, J. B. L.
Hungerford, L. S.
Hungerford, W. R.
Hunter, Percival
Hincher, W. W.
Jenks, C. D.
Jett, E. E.
Johnson, C. H.
Jones, L. E.
Keeler, B. A.
Keeler, Sanford
Kelley, H. D.
Kelley, J. W.
King, C. H.
Kucher, T. N.
Lanby, J. S.
LaRue, H.
Lewis, J. H.
Lickey, T. G.
Little, J. C.
Lowder, R. S.
McClain, H. O.
McEachren, J. W.
McLelland, H. B.
Mackenzie, D. R.
Maher, J. T.
Manchester, A. E.
Markle, J. R.
Midgley, S. W.
Mohle, C. E.
Monroe, M. S.
Moody, W. O.
Moore, P. W.
Morris, T. R.
Motherwell, J. W.
Nathan, C. A.
Neff, J. P.

Odegaard, A. J.
Osmer, J. E.
Otto, Oscar
Park, H. S.
Parker, P.
Pechin, F. R.
Peck, P. H.
Penner, Carl
Pflager, C. W.
Phillips, L. R.
Place, F. E.
Pratt, E. W.
Price, R. C.
Rourke, Wm.
Rowley, S. T.
Russell, M. F.
Rutherford, F. H.
Schroyer, C. A.
Seley, C. A.
Sharp, W. E.
Sherman, L. B.
Slaughter, G. F.
Smith, L. L.
State, R. E.
Stott, A. J.
Sweringen, F. H.
Sweringen, G. N.
Symons, W. E.
Taft, R. C.
Talmage, J. G.
Talmage, W. C.
Tawse, W. G.
Taylor, C. H.
Taylor, J. W.
Tenney, B. E.
Thomas, I. W.
Thompson, J. R.
Toltz, Max
Tonge, John
Towsley, C. A.
Warner, H. E.
Webb, E. R.
Wickhorst, M. H.
Willcoxson, W. G.
Winn, C. F.
Woods, E. S.
Wright, Wm.
Young, C. B.
Younglove, J. C.
Zealand, T. H.

President Seley: The meeting will please come to order. We expect rather a large attendance and would be interested in putting in our next proceedings a very full list of those attending, so that we will thank you, if you have not already done so, to put your name on a card at the door.

The minutes of the last meeting have been printed and issued. If there are no corrections, they will stand approved.

We will now have the report of the Secretary.

The Secretary: Mr. President, I have the usual membership statement.

Membership, November, 1907		1427
Dropped—Non-payment of dues	12	
Resigned	1	
Dead	1	14
		1413
New members approved by board of directors		24
		1437

DROPPED—NON-PAYMENT OF DUES.

J. H. Van Buskirk, 610 Grand Central Station, New York.
J. B. Allfree, 1446 Wilson Ave., Chicago.
F. P. Barnes, Grand Junction, Colorado.
Stanley Woodworth, 100 Lake St., Chicago.
M. H. Wilkins, Grand Island, Nebraska.
F. G. Whipple, Old Colony Bldg., Chicago.
A. W. Wheatley, American Locomotive Works, New York.
S. S. Voorhees, Washington, D. C.
F. E. Smith, Elkhart, Ind.
A. M. Smith, Detroit, Mich.
E. G. Rost, Baltimore, Md.
H. O. Westmark, Aurora, Ill.

RESIGNED.

John Conrath.

DEAD.

Prof. Storm Bull.

Edmund W. Tetlow, Salesman, Western Tube Co., 922 Marquette Bldg., Chicago	G. M. Crownover
R. W. Schulze, Genl. Car Foreman G. C. & S. F. Ry., Cleburne, Tex.	J. E. Epler
Chas. H. Benjamin, Dean. Eng. Schools, Purdue University, Lafayette, Ind.	L. E. Endsley
J. F. Whiteford, Gen. R. H. Insp. A. T. & S. F. Ry., Albuquerque, N. M.	J. E. Epler
F. C. Cameron, Draftsman, Natl. Dump Car Co., Railway Exchange, Chicago	H. B. Hatch
J. W. Snead, M. E. Gravity Coal Bin Co., Railway Exchange, Chicago.	H. B. Hatch
D. Walker Wear, Storekeeper, C. I. & S. R. R., 4201 Ellis Ave., Chicago	W. McMaster
E. H. Landers, Storekeeper, L. S. & M. S. Ry., Chicago.	W. McMaster
P. C. Cady, L. S. & M. S. Ry., Cleveland, Ohio	G. N. Dow
Edwin F. Leigh, Repr. Chicago Railway Equipment Co., Chicago	W. B. Hall
Clifford A. Nathan, Nathan Mfg. Co., Chicago	Sanford Keeler
J. W. Dalman, Latrobe Steel & Coupler Co., Chicago	J. W. Taylor
C. J. Albert, Mgr., Cleveland Pneumatic Tool Co., Cleveland, Ohio	J. G. Talmage
W. C. Talmage, Ry. Steel Spring Co., Cleveland, Ohio	J. G. Talmage
J. T. Maher, American Steel Foundry, Chicago	H. T. Bentley
W. F. Buck, Mech. Supt. A. T. & S. F. Ry, Topeka, Kan.	W. L. Allison
C. W. Pflager, Asst. Mech. Supt. Pullman Co., Chicago	M. K. Barnum
T. H. Garland, Gen. Agt. Repr. Service C. B. & Q. Ry., Chicago	M. K. Barnum
G. T. Cooke, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
Carl S. Clingman, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
W. R. Hungerford, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
Roswell P. Cooley, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
Wm. Rourke, Gen. Car Foreman, A. T. & S F. Ry., Chicago	C. C. Higgins
J. B. Cunningham, C. C., A. T. & S. F. Ry. Shops, Chi-	C. C. Higgins

President Seley: The number merely lacks 165 of what I hope to see before I turn over the gavel to my successor.

The paper of the evening is "The Education of Young Men for Mechanical Pursuits," and will be presented by Mr. R. T. Crane, Sr., President of the Crane Company. I take great pleasure in introducing Mr. Crane.

Mr. R. T. Crane (Crane Company): Mr. President, I think it was understood that I did not come here to make a speech and that I did not come here to read a paper. I do not know whether the audience understands that or not, but that was my understanding of the conditions under which I came here. I do not know that it is incumbent upon me to make an apology, but I never could make a public reader or a public speaker of myself. I am a founder and I am not ashamed of it, but I have prepared a paper with considerable time and trouble and have put a great deal of thought on the subject. It is a thing that has been in my mind for a good many years, the problem of making mechanics and what education and so forth

it required, and I have had this paper prepared and if agreeable, I will have it read.

PRESIDENT SELEY: We will be glad to have it in any way you choose.

The following paper was then read by Mr. J. W. McEachren.

THE EDUCATION OF YOUNG MEN FOR MECHANICAL PURSUITS.

Mr. President and gentlemen: You have asked me the following questions, which I shall endeavor to answer in their order, clearly, and as briefly as, in my judgment, their importance will permit:

1. Why do I support manual training in the common grade schools?
2. Why do I not believe in so-called technical education?
3. Why do I oppose trade schools?
4. What educational features should be included in the training of apprentices?

At the outset I shall assume that no exception will be taken to the general assertion that the fundamental purpose of education is:

To aid boys and girls in becoming self-supporting and good citizens.

Manual training helps to make mechanics, and I regard mechanics as being of the greatest importance to the world; for they have given us, and continue to give us, a very large proportion of all that contributes to our comfort and happiness.

Some maintain that the chief object of education is to make people happy. Admitting this to be so does not in the least affect my argument, for I hold that no person can be genuinely happy unless he be self-supporting, and that the most direct road to happiness, therefore, is that by which, through judicious training, boys and girls are taught to earn their own living.

And as the great bulk of our boys and girls—about eighty per cent, I understand of those who enter the common schools—get all of their formal education in the grammar grades, it follows that here should be concentrated our most earnest efforts toward realizing the fundamental purposes of all school training.

But you may ask: Why do we need manual training, now, as a recognized feature of grammar school teaching, when we have got along all these years so successfully without it?

While this manual training question has been talked about and discussed for years, it could have been applied long ago as I advocate it, and to decided advantage for the good of the child.

But now it is of the greatest importance, because marked changes in the industrial field—the systematizing and classifying of labor, specializing, and the rapid growth of automatic, labor-saving machinery, have made it no longer as practicable as it used to be for

the manufacturer to undertake the preliminary training of boys in mechanical lines. Still, it is essential to the welfare of society and of the country that boys be so trained, and this training I consider a proper function of our public school system.

Still another question may be raised along this line: Why is the manufacturer interested in manual training? If he needs mechanics, why doesn't he make them for himself?

To my mind a sufficient answer to this, in the present connection, is that as public opinion in this country seems to be against the holding of boys by law to a definite term of apprenticeship, it is not to the advantage either of the boy or the manufacturer that the latter should undertake to carry him through the early and most expensive stage of a single trade when, under a liberal system of manual training, he would gain a fair working knowledge of several trades.

There is a wide field for the all-round mechanic. Industrial supervision constantly invites him. And the boy who goes from the grammar school to the industrial field with a good general knowledge of practical mechanics, in several lines, gained through intelligently directed manual training, will be the best equipped for advancement to the higher positions.

Does such manual training pay? I am confident that it does, not only ethically, but in actual dollars and cents.

It is about sixteen years since I gained the consent of the Board of Education of Chicago to put my beliefs to the practical test in the Tilden school, over on Lake Sreet.

The boys from the three higher grades received instruction for an hour and a half each week. At the end of three years these boys had learned to do a creditable piece of carpentry; they had learned how to handle and take care of tools; and they knew a good deal about materials.

I figured that it had cost me about $3 a pupil to give this three years of training. When I considered the immense amount of good this was doing for the boys who had received it, I was convinced that I was making a good investment, and when the matter was put in this practical light before the school authorities they heartily approved of the system and adopted it as far as their means would allow.

However, as I did not wish to see the good work lag from lack of support, I aided the school authorities in establishing five other grade-school manual training centers, giving a three-year course, and also provided quite a number of scholarships to help in the preparation of manual training teachers.

It is confidently expected that with this assistance the city will be in a position, in the course of a few years, to carry on manual training work throughout the grammar schools to the same extent as in my first experiment—that is, in the last three years of the grades.

Encouraged by the marked success of the three-year course, I de-

cided to carry out my idea through the eight years of grammar school study. This was started some four years ago in the Tilden school, and from the results so far attained I am confident that the outcome will be highly gratifying. I estimate that the entire course of eight years can be given throughout the grammar grades for about $15 a pupil. And I hope to live to see the day when a full course of eight years in manual training will be an established feature of every grade school in the city and of every school day in the year.

Before leaving this part of my subject I wish to lay particular stress upon one well proved fact: Manual training is a powerful moral agency. It increases the interest of the boy in the general work of the school. He likes his other studies better because he spends part of his time learning to do attractive and useful things with his hands. This increased interest tends to keep him off the street because it lessens the temptations to truancy.

Carry this manual training idea out to the extent I advocate, and I firmly believe there would be much less need than there is now for reform schools and like agencies to keep boys from a criminal life. If for no reason other than this, money spent for manual training is about as good an investment as the public can make.

I now come to your second question: "Why do I not believe in so-called technical education?"

I assume that in asking this you understand that I treat technical education as a means of making mechanics, and that any criticism I may make of it is not intended to apply to such lines of special training as are necessary for the electrician, the civil or mining engineer, the chemist or the teacher.

With these points held clearly in your minds, I answer that I oppose technical education chiefly because in my long experience in business I have seen no practical results coming from technically trained men.

I lay strong emphasis on the practical side. The period of a boy's life usually devoted to technical education is the most important in his whole career, and should not be devoted to anything questionable or speculative. Technical schools are built, supported and managed by impractical people, and they are not qualified to play a part in the training of boys who have to earn their own livelihood.

I most emphatically disagree with the popular belief that a technical education is necessary to the production of good mechanics, firemen, superintendents, etc.

So far as manufacturing is concerned I am most decidedly of the opinion that time spent in technical schools is absolutely wasted. I as strongly believe that technical education is a positive drawback in nearly every mechanical line.

For example: I glance over a recent bulletin of one of our technical schools and see that the students will make "astronomical obser-

vations and computations to determine time, latitude, and azimuth;" that they will have advanced work in "differential and integral calculus, mechanical differentiation and integration, calculus of imaginaries and hyperbolic functions," and that "eliptical functions" will be defined. There also will be "addition and multiplication of determinants" and some exercise with the "ellipsoid," the "hyperboloid" and the "paraboloid."

Now these things may be all very well in their place and very interesting to a few, but how in the name of common sense are they going to help a young man to be a good, all-round, practical mechanic?

Will knowledge regarding differential and integral calculus enable him to run a lathe or work at a vise?

Can a foreman do his work better if he be on intimate speaking terms with the azimuth?

Because a superintendent can roll ellipsoid, or paraboloid as a sweet morsel under his tongue, is he the better fitted to select and to control his men?

Ordinary common sense gives a most emphatic NO to these questions.

The youth who gets a few of these things into his head, in some hit or miss fashion, may feel that he is securing knowledge essential to his progress, and consequently he comes out of the technical school and goes into the shop with the idea that he is superior to the boy wholly shop-trained.

His head is swelled to such an extent that he is unable to grasp the practical things that *are* essential to his advancement and success. In fact, if such a lad does succeed, as a mechanic, it is because he has sense enough to profit by the knocking around he is sure to get in the shops and to drop his false ideas so that he may begin to learn things of real practical and material value to him.

I maintain that what is necessary for men to have to be successful in manufacturing is a thorough knowledge of the art, of the kind of machines best adapted to certain purposes, and of how much the machines are capable of producing. These prime essentials are not found in a course in technology, but in long experience and close observation in the business and in a thoroughly up-to-date factory.

Many are deceived in regard to the value of technical education by the fact that some of the graduates from technical schools get into good positions. Undoubtedly this is true, but only to a very limited extent.

I maintain that where one technical graduate secures a good position, a dozen boys, who have had none of this technical training, also get good positions, and fill them equally as well as, or better than the technically educated young man.

It would be most surprising if the technical schools did not turn out something above the average now and then, when we remember

that as a rule none but the brightest boys are sent to such institutions. And this, to my mind, is one of the strongest counts against this class of higher education: It has its pick of the best and brightest, yet with such working capital it makes no adequate returns.

I know of one concern that tried twenty graduates of technical schools and I am informed that of this number seventeen proved absolute failures, two were indifferently successful, and only one turned out to be a decided success.

As an argument on the other hand I know of one large manufacturing concern in this country that, despite the fact that it was surrounded by technically trained men, chose its superintendent from the ranks of its common laborers, giving him a position that paid $12,000 a year.

I also know that the original steel plant at South Chicago was built and put in full operation by a German who had no formal education, technical or otherwise.

I might also cite the case of a man I know who took a course in architecture in the "Boston Tech," and afterward admitted that before he could make any progress in his profession he had to forget about all that had been taught him in that school.

I don't know of a case where a technically educated man has built up a manufacturing business of his own and carried it to marked success. In fact it is rare to find instances where technically trained men have assisted materially in the building up and management of great industrial enterprises.

For the young man or boy who intends to follow a mechanical or manufacturing career, a course in a technical college is a waste of time and money. Four years in the shops, learning his trade or business, will be of far more use to him than the four years usually required for a technical course. He will get all the theory he needs while learning the practical side of his calling, and he won't get so puffed up with carrying around a load of book knowledge that he will stand in his own light and miss opportunities for advancement.

Practically all the progress that has been made in the world thus far has been without the aid of technically trained men. In support of this I have only to name, Watt, Stephenson, Dudley, Brasse, Napier, Naysmith, Russell, Koenig, Bramah, Maudslay, Clement, Fox, Whitworth, Fairbairn, Smeaton, Kelley, Field, McCormick, Edison, Howe, and a score of others.

These were foundation builders in mechanics, and practically every one of them attained success and fame without formal technical training and with precious little general education.

Why, then, do we hear such enthusiastic claims today for what technical education is doing? Why such boasting about what Germany is doing in a technical way till that country has become one of our bug-a-boos? As far as mechanics is concerned we have nothing to fear from Germany; but it is undeniable that Germany has much to learn from us.

One or two facts will illustrate this. A year or two ago my son, while in Germany, visited a large electrical plant in Nuremburg, and found that this factory not only was filled with American machinery, but was managed by Americans.

While talking with a gentleman a year or so ago concerning the manufacture of agricultural machinery in Germany, he made the statement that on a recent visit to that country, he had seen a factory that was being fitted up for the manufacture of reapers and that was completely equipped with American machinery.

If Germany is so far ahead of us mechanically, why does she buy our machinery for her factories, and hire our mechanics?

Who ever heard of Americans buying extensively of German machinery or employing German mechanics as foremen and superintendents? If she is so great in this line as some would have us believe wouldn't there be a great demand for her machinery and mechanics?

At this point I can imagine someone asking: Why do such men as Carnegie and Armour put millions into technological schools when their own millions came chiefly through the aid of non-technical but practical men?

By the way: I feel that I must point out here what I consider the glaring inconsistency between what Mr. Carnegie says and what he does, because so many look upon him as a wise man and as having had such a wide practical experience in mechanics that his opinions carry considerable weight.

I quote briefly from his book: "The Empire of Business," published no longer than five years ago. In the chapter on "How to Win Fortune," after giving a long list of the best known industrial establishments in several lines in this country, Mr. Carnegie says:

"Every one of these great works was founded and managed by mechanics, men who served their apprenticeship. The list could be greatly extended, and if we were to include those which were created by men who entered life as office boys or clerks, we should embrace almost every famous manufacturing concern in the country."

Further on, in considering successes in mercantile, commercial and financial enterprises, Mr. Carnegie makes this significant comment:

"The absence of the college graduate in this list should be deeply weighed. I have inquired and searched everywhere in all quarters, but find small trace of him as a leader in affairs."

And a few lines further:

"But the almost fatal absence of the graduate from high positions in the business world seems to justify the conclusion that college education as it exists seems almost fatal to success in that domain."

Turn a page or two and we find the assertion:

"It is the poor clerk and the working mechanic who finally rule in every branch of affairs, without capital, without family influence, and without college education."

Now, after all these illustrations, based on his own practical experience and observation, in favor of the practical man and against the technical man, or college graduate, Mr. Carnegie enters the field of pure speculation, imagines that technically trained men would be a good thing for mechanics and backs his fancy with a $12,000,000 technological institute. This is nothing more than a whim of his, for his experience with technical graduates has been too short to warrant him in passing on their merits.

If he had taken that $12,000,000 and added another $12,000,000 to it and dumped the whole amount into the ocean, this country would be better off.

Mr. Carnegie has argued that it is a good thing for him to have so much money because he can use it for the benefit of the public. Is it benefiting the public to put $12,000,000 into his technological institute to turn out a class of young men destined, according to his own unequivocal assertion, to be distanced in the business race by "the poor clerk and the working mechanic?"

In his speculative mood Mr. Carnegie says that technically trained men are open-minded and free from prejudice. I should like to know on what he bases such an assertion. My own experience has been just the contrary. I have found them set in their ways. They will not do a thing in a straightforward reasonable way, I suppose, because that is the way a practical mechanic would do it.

I leave it to you, gentlemen, if Mr. Carnegie has taken the course a sound business man would follow. If I had the naming of his institute I should call it,

"Carnegie's Twelve-Million Dollar Blunder."

As to your third question: I am opposed to trade schools for the simple reason that I think they go altogether too far.

I can see no need for teaching a boy a trade in any line in a special school. If he be given a moderate amount of manual training he should have no trouble in getting a place in a shop where he may learn a trade much better than any school can teach it: and besides be earning something instead of being an expense to himself, his parents or the public.

The place to learn a trade is in the shops. Even a graduate of the best trade school in the world would have a whole lot to learn in the shops before he could be considered efficient. Then why waste time in the trade school? Why not go into the shop in the first place.

Let me illustrate this from my own experience: After I had learned the brass business, I made up my mind that I preferred to be a machinist. The experience I had in the brass business did not fit me for a machinist much better than that I would have got in such a course of grade school manual training as I advocate.

But I went into the machine shop, receiving modest wages as a machinist, and at the end of a year I was getting the highest wages.

I simply cite this as an example of the advantage I am confident

boys will have in good, practically conducted manual training schools. And now for your fourth and last question: What educational features should be included in the training of apprentices.

They are all provided, or should be provided, by our common schools. I would have apprentices possess a reasonably good understanding of English. They should be able to read well and rapidly. They should write a plain hand with reasonable rapidity and read writing readily. They should have a well-grounded knowledge of common arithmetic so that they may work out ordinary problems quickly and accurately. And they should know enough about mechanical drawing to enable them to read drawings and to make reasonably good drawings.

Men or boys who are deficient in any of these things may acquire the requisite knowledge in the public night schools or from well-selected reading and practice at home. All the special knowledge they may wish may be gained from books, and our public libraries are open to all who wish to use them.

There are no problems in the factory that can not be solved with the aid of a good common education and ordinary intelligence.

I have answered your questions, gentlemen, in the light of years of experience and observation. I am glad of the opportunity you have given me, for I consider these questions of vital importance, and that my experience in business enables me to speak with knowledge and confidence on these matters.

I am particularly glad to speak to you as I have tonight, because there is growing up altogether too great a tendency to favor technical and higher education, and because the favoring comes from so many persons who are lacking in practical knowledge.

This is likely to result in enormous damage, and it is high time the public became more enlightened on the subject. To my mind there is no matter in which the people are so much in error as this subject of education. I stand first of all for our grade schools, and am strongly of the opinion that, for the present at least, all the money that a city or a community can afford to spend on public education should be devoted to the grammar schools. Anything beyond this I do not consider to be properly part of a free public school system.

I challenge the right of any board of education to use the public money for the building of expensive high schools, and I question the wisdom of putting money into colleges and universities, so long as there is room for improvement in the public grammar schools.

There is something radically wrong with a public school system that can find $500,000 for a single high school building, and only a paltry few hundred dollars for manual training in the grades.

It was just such a situation as this in Chicago that prompted me to support manual training where it is most needed, and to point out the proper place to put any half-million dollar find that the school

board fancies would look well in a beautiful—though unnecessary—high school structure.

I do not believe in building a house on an insecure or unfinished foundation; but that is exactly what we are doing with most of the money that goes into high schools, colleges, and universities, and with all of it that goes into technical education for the training of mechanics.

Mr. McEachren: By the way, Mr. Crane wished me to say that at the time he was asked to prepare this paper he wrote a letter to Mr. Carnegie, telling him that in his paper it was his intention to attack him on his own ground, giving him a fair chance to present his own side of the case as strongly as he could, and that his answer would be considered in connection with the paper, so that he could not say that Mr. Crane had taken an unfair advantage of him. So far no answer has come to that letter and of course we cannot give Mr. Carnegie's side of it. The letter to Mr. Carnegie asked the questions bluntly, which I will mention:

1. Do you owe your success in business to any considerable extent to technically educated mechanics in your employ?

2. If so, what proportion is due to this class of men in your employ and what proportion to mechanics who are not technically educated?

3. If you do not owe any of your success to technically educated men, why do you establish a college to educate such men?

4. In your experience, aside from your own business, have you observed that technically educated men are more successful than those who were not so educated?

That was, I think, giving Mr. Carnegie a very fair chance, and if his letter had been received, it would have been taken in as part of this paper.

President Seley: I feel that we have been unusually favored in the paper of the evening as being a very direct expression of opinion, which is backed by experience and knowledge from at least one side of the case, and I think that it presents a most prolific field for discussion.

It is particularly interesting to the railroad men on account of the necessity for increasing the ranks of intelligent workmen, and while this is a railroad club and we incline more toward railroad problems, I think that every one has felt that the general proposition as stated in this paper of education for any class of mechanics is interesting and worthy of the deepest thought and attention.

It has been my privilege to attend the conventions of the Master Mechanics' Association for some years, and the tendency in the last three years has been to devote more and more time to this very point, the matter of the education and fitting of the apprentices, and in fact, the last two years particularly I recall that these and kindred topics have taken at least one-half of the time of the convention of

railroad men who come from all parts of the country to attend, and I feel that the Western Railway Club is particularly fortunate in taking up this topic and to have had this very able presentation of it.

The subject is now open for discussion. Prof. Endsley, will you start the discussion:

PROF. L. E. ENDSLEY (Purdue University): There always has been, and I suppose there always will be, a strife between the purely practical man and the purely theoretical man, but the closer we can bring them together, the more successful will be our engineering undertakings. A purely practical man is of value—a purely theoretical man is possibly of little or no value, but the modern technical man who has a practical view of things along with his technical training is the man of greatest value in the engineering world. Of course, several years ago, our technical schools were purely theoretical in character. They dealt only with the theory of engineering, But today our technical schools, as equipped with the pattern shop, the foundry, the machine shop and the forge room, give the technical graduate a very good knowledge of the practical side of engineering. The number of graduates being now turned out every year is way in excess of that of ten years ago, nevertheless the supply is not equal to the demand. In practically all of the schools of the country, the success achieved by the graduates is the factor which is drawing more and more men to technical schools.

Of course, we know that to-day there are a great many successful men in the engineering world who are not technical graduates. This is true and always will be so but I believe the time is coming when successful engineers who are not technical graduates will be rare.

PRESIDENT SELEY: We have a gentleman that has come from some little distance whose standing as a mechanic I know is second to very few in the railroad line. I would like very much to hear from Mr. Tonge, of the Minneapolis & St. Louis R. R.

MR. JOHN TONGE (Minn. & St. Louis R. R.): Mr. President and members of the Western Railway Club: I think that the railroads and the manufacturing firms of this country have had an excellent opportunity in the past four years to see the mistake they have made in not educating the apprentice as he should be educated, this; I believe, you will concede. It has been too much the custom to take an apprentice in the shop, set him to work in some corner possibly all alone and may be keep him on one class of work for months and months, making him disgusted, probably, with the choice of a trade he has made. He is not given the attention he should be given, either by the foreman or mechanic. By the mechanic because he has no desire to see him become proficient. By the foreman because, as my experience goes, the foreman is so loaded down with other duties that he himself cannot find the necessary time to devote to the education of the apprentice and it is only on rare occasions where you

find a foreman who has such an active mind as to enable him to take up quickly the duties of a foreman.

The trade organizations have cut down the apprenticeship list to a very great extent and it is the railroads and the manufacturing firms who are to blame for allowing their rights to be infringed upon by the labor organizations. This infringement should have been fought out at the commencement, for the reason, as I believe, that trade organizations have no right to say who shall be hired or how many of any class of labor, it should be your privilege to employ. Where you had four years back, almost any number of apprentices under your charge, what have you today? You have one in five as against the previous unlimited number. In one of the shops of which I have charge we had fifteen apprentices; in the same shop we now have five apprentices and I would ask if you have ever heard of a railroad company giving a foreman credit for educating apprentices and making a saving of $3.00 per head per day? Your reply must be *NO*. When you have a good man why not let him feel that you know it and tell him that you appreciate his labors and convince him in a substantial way for his labors, because the troubles of a foreman are many and his labors great, and for this reason I am safe in saying that neither the railroads nor other corporations gave the subject of educating apprentices very much consideration, if any, and for which neglect they are now paving at the rate of $4.00 per day for mechanics to fill the places of the apprentices, whom they were deprived of having and who were as valuable to the corporations after a year's service as any of the mechanics employed. There are very few foreman who are fit persons to have charge of boys. A foreman who is not endowed with much patience or too easily disturbed by his other duties calling for his attention, is by no means the man to have charge of educating apprentices. By the proper selection of foremen, instructors or superintendents, I do not hesitate to say that it is within the bounds of possibility to organize an apprentice shop on any railroad so that the work can be done thoroughly. If you have thirty, forty or even 100 apprentices for that matter, make and equip your shop accordingly. Let it be known as your apprentice apartment. Have your machinery systematically arranged so that there will be no confusion among them as they are changed from one position to another, so that an apprentice who has taken his position as No. 1 on a machine, is next to No. 2, etc. Boy No. 1 having been instructed by the foreman and boy No. 2 noticing that he is not following the instructions given him by the foreman, immediately corrects him. You will readily see by such an arrangement that the foreman has as many assistant foreman, so to speak, as he has apprentices, with the exception of boy No. 1, and the task which appeared so difficult and makes so many firms and railroads afraid of taking up the question, becomes a very easy task after all.

I would like to hear of some General Managers, a large number of them on the Great Trunk Lines, sending for their motive power men and ask them to sit down for a few hours' conversation and explain to them what can be done with the apprentice and for him in order to make him a thorough mechanic. Then it would be in line for the motive power men to outline to their superior officers, a shop composed of 50, 75 or 100 apprentices, with machinery properly arranged, whereby they could commence with the smallest piece of work necessary to be used, up to and completing any piece of work and if needs be, to build the engine entire, and it should be understood that no journeymen shall work in this shop, for with the journeymen there would be opposition to every effort put forth by the foreman and apprentice, which, in the mind of the journeyman, should not be done, so you see you would eliminate from the ranks of the apprentice, the man who is opposed to an honest day's work.

There is much to be said about the apprentice. My instruction to apprentices, and I impress it upon them most thoroughly, is to see how *much* they can do and not how little. If they want, as I often say to them, to be a drone after they have served their apprenticeship, they can make the choice, but it has been my experience to find none. Another very interesting thing—the foreman approaches one or more of the boys who are working on large machines, so that considerable time is occupied in the machine traveling over its work, he says to a boy "Harry, what are you thinking about?"; the boy replies "Nothing in particular;" then the foreman calls his attention to work which will be done possibly by an older boy and says to him, "Imagine that you are going to do that work, consider it and I will be back after while and ask you to tell me how you would do it." The point is not to let the boy's mind get sluggish. If you see he has a moment's time for considering anything, put the matter before him, in other words, get after him, do not let him stand around for a minute, crowd him, make him work in his mind, and after awhile it will come to his fingers and he will know what to do.

Mr. President, I am very glad indeed to see that in the past two years the apprenticeship has been given much consideration by a few eastern lines, one in particular, the New York Central, and there is no one better able to make the assertion, or even has the right to make the assertion as follows than myself,—That the official on the New York Central who has been so interested, did many years ago have for himself an object lesson from which he has some knowledge and put it into execution and as the good preacher says "Cast thy bread upon the waters and it will return after many days." It has done my heart good to realize that fact and that one of my long acquaintances is thoroughly imbued with the duties which the corporations owe to the apprentice and if followed out as it should be, by all corporations, we should have, in not many years, thoroughly established the all around mechanic.

PRESIDENT SELEY: I know that I have met a good many mechanics that were a credit to Mr. Towne's efforts to get them in the right way for their mechanical training, and I think there is much value in his remarks. It strikes me that much of this difficulty is due to its being a stern chase and that is always a long and hard one. We have to take boys into the shop to make mechanics of them that have not gotten what they should have obtained in the grade schools. I hope they may get it in time and if Mr. Crane's idea is carried out, they will get it. In the meantime, or just for the present generation and for the present time, I believe that the school has got to go into the shop to a considerable extent and not only for instruction in the fundamental mathematics and other studies that will properly fit them as mechanics, but these instructors also should go with them into the shop as shop intructors and pay attention to the boys, the work and the tools. The foreman cannot do this as thoroughly and entirely with a large shop and a number of apprentices as he should, and by having a proper corps of shop instructors to go also into school matters, it may be worked out somewhat on the lines perhaps as the New York Central is doing, and will be the most immediately productive method by which we can raise the standard of our mechanics. I would like to hear some more from the college side.

MR. M. K. BARNUM (C. B. & Q. Ry.): I agree with Mr. Crane in some of his criticisms of the prevailing courses of instruction in the graded schools. As a rule the public schools pay too little attention to what have been called the "Three R's" and introduce too many extras, some of which may be called fads, with the result that the pupils are not well trained in those rudiments which are so essential, whether they are to have a higher education or not.

I think his criticisms of certain subjects found in many of the technical college courses are also justified. After taking a full college course with a post-graduate degree, and, having considerable practical experience, I have come to the conclusion that much of the time spent on such branches of study as mathematical astronomy and some other similar subjects, if not wasted, at least, might be more profitably applied to subjects which will furnish equally good mental training and will be of far greater practical value to the student after he gets into his fight for practical success in life.

To some of Mr. Crane's propositions, I must take exception, and one is that all of the brighter boys from the graded schools go to college. In most cases the question of a boy's going to college is not a matter of brightness or dullness, but it depends either upon his ambition, or more often upon his financial ability to pursue a more extended course. I believe it is safe to say that nine-tenths of the boys who leave school during the grade or high school course do so because they or their parents cannot afford any further expense for their education. Therefore it is not fair either to them or to the college graduates to say that the latter compose all of the

brightest boys who enter school. If many of the bright boys do not stop school before entering college, then it must follow from Mr. Crane's statements that the successful mechanics and shop managers were all dull boys, which is inconsistent. There are at least fifty shop mechanics to every graduate of a mechanical engineering school, and it would be very remarkable if, from so much more material, the number of successful shop managers should not compare well with the number found among technical graduates.

Furthermore, I believe that the successes of the technical graduates have been underrated in the paper. As a rule successful manufacturers wish their sons to have a technical education and therefore they must place a higher value on it than does Mr. Crane.

If we take all the manufacturing and mechanical lines including the railroad business, and check up the men holding the high positions, we shall find many graduates of technical schools among them. Why is it that all the members of graduating classes of all the mechanical engineering schools are sought after and engaged before graduation by such concerns as the Westinghouse Mfg. & Mach. Co., The General Electric Co., the American Locomotive Company and the United States Steel Company if they have not been found to be of some practical use?

President Seley: I think the point raised by Mr. Barnum is well taken, and I was particularly struck with the excellence of an editorial in the Engineering World appearing recently, and I had hoped very much that some one would be here to add to this discussion on the lines of that editorial. I would commend the reading of it to every one present. Mr. Basford has come a long distance to attend this meeting, we would like to hear from him.

Mr. G. M. Basford (American Locomotive Co.): Our common schools do not interest and hold boys to-day; they do not fit boys for the struggle of life. Manual training will probably change all this. It is the most promising development in education at the present time. It will undoubtedly grow in influence and in a comparatively short time it may change the entire complexion of our educational systems. There are directions in which manual training will work to the advantage of our manufacturers and railroads, but there will be a little time at least before the development can be direct enough to fill the need which is now great and is daily becoming greater.

Every one is having trouble to find foremen, superintendents and managers. It is even more difficult to find enough good workmen. Good workmen seldom apply at our gates for work. We must depend upon ourselves to develop them. There may be as many good workmen as ever, but with increasing demand there are too few to go around. Nowadays no one has time to know them, much less to train them. We have drifted a long way from the

methods which were successful in past years, but even these will not answer at all now.

In all our shop organizations we need professional trainers of men who will devote themselves exclusively to the recruits, to the boys on whom we are to depend in the future.

It does not matter where the boys come from as long as they have the making of dependable men. It does matter, however, that they should come into contact with some one who can initiate them into the mysteries of a working organization and lead them to take their places among men.

It is also important that some one should know, personally, the capabilities of every boy in the organization.

If we had some one in position to "pick the winners" among apprentice boys and develop them, many present problems of organization would disappear. By "winners" is meant the sturdy, worthy boys, who will make good workmen. Those of genius, capable of becoming leaders will then reveal themselves.

If we introduce to-day a new apprenticeship with shop instructors and shop schools, co-operating to educate brain and hand together, there will not long be any difficulty as to good workmen, good foremen, superintendents, managers and even chief executives.

Neither trade schools nor technical schools will solve our organization problems. Correct apprenticeship will solve them. I should add a word of explanation there, I think. I mean that we cannot depend upon any outside influence, whether a common school with manual training, or a technical school, or any other source outside of our large organizations for the men they want to do the responsible work in those organizations. They may have a part, and a very important part in the preparation of these men but a very large part must always remain with the organizations themselves.

The speaker of the evening has raised a most important question when he asked: What educational features should be included in the training of apprentices?

In the words of the Massachusetts Commission of Industrial and Technical Education, we should give them:

"Mental power to see beyond the task which occupies the hand for the moment, to the operations which have preceded and those which are to follow; power to take in the whole process, knowledge of material, ideas of cost, ideas of organization, business sense, and a conscience which recognizes obligations."

This is a large undertaking, but there can be no more promising opportunity for big organizations to-day.

Mr. F. H. Clark (C. B. & Q. Ry.): I feel that I am hardly qualified to speak on the paper, as I came in late, and really do not know what Mr. Crane's ideas are. I understood, however, from the latter part of his paper that he was not at all in favor of technical education. I believe there are two sides to that question and

that there are some strong points in its favor. It is probably not necessary or desirable that all mechanics should have a technical education, but I do believe that there is a big field for technically educated men, especially perhaps in the designing of electrical machinery and equipment, and in chemistry. I do not think that the development in electrical machinery that has taken place in the past 20 or 25 years could have been brought about without the help of higher mathematics and other features of a technical education.

I do not think that any technically educated man is likely to have need in after life of all the subjects he may have to consider while in college, but that, perhaps, is not the fault of the system, as a very small percentage of college men know exactly what they will do in after life and are unable to map out such a course as would best meet their future requirements.

I thoroughly agree with the speakers who have spoken in favor of more attention to apprentices. They are very likely to be slighted, especially at times when we all feel that every move must count, and I hope that the railroads and other organizations that have taken the matter up in a careful way will reap a benefit from their endeavors.

Mr. P.H. Peck (C. & W. I. R. R.): I have been a member of the Western Club a great many years. About twenty years ago we commenced educating the apprentice boy in our discussions at the Club. This boy must be married now and has a family. There is hardly a year that something isn't said about the boy in school and the railroad shop, but still we are not much better off than we were before. Personally, I do not think that you can run a school in connection with a railroad shop. I think the boy should get his schooling in the public schools before he enters the shop, and then if he takes to machine or shop work, it does not take the machine foreman long to find out whether he will make a good workman or not. A great many apprentice boys have the wrong idea of a shop and leave it a few months after entering. Quite a number do not stay in a shop long enough to learn a trade, because they do not like it. A man in charge of a railroad shop must give an account of the expenses of the shop and the output, and he derives no benefit from educating an apprentice boy until he has learned his trade. Of course, large railroads with large shops can take more pains in educating men than smaller companies with small shops, but I have never yet, since I have been master mechanic, seen a boy who took to machine work or any shop work, that did not make a good man out of himself after he has been there four years. Others who do not take to it stay many years and are not first-class work men when their trade is finished. I think you will find that in every profession. I do not think education hinders a man in learning a trade and after the trade is learned the education he acquires is certainly a benefit to him.

Mr. Wm. Forsyth (Railway Age): I am somewhat familiar

with Mr. Crane's ideas about education, because I read the first and second edition of his pamphlet on the subject at the time it was published and when I met him this evening he said, I might not agree with him, and I told him I did not.

Not referring to the first part of his paper, but rather to his objections to technical education, the subject is rather confused, it seems to me. There are several branches of education, and I am quite in favor of a trade school and a high school manual training school as a preparation for apprentices,—and I think it is possible to favor that kind of education without objecting to technical schools and technical graduates and ignoring their value in relation to the great industries of this country.

Mr. Crane's first remarks relate to the value of an education as making a man self-sustaining and helping him earn a living. Now, there are quite a number of technical graduates here this evening and I know they are all earning a good living; they are earning a larger salary than the machinist and a technical education has been a greater advantage to them than if they had only obtained a trade school education.

Mr. Crane referred to the design of the South Chicago Steel Mills and said they were designed by a German mechanic, or rather that it was built by a German mechanic, but I want to remind him that the South Chicago Mills were designed by an engineer, a graduate of the Troy Polytechnic School and his name is Robert Forsyth. But for the work of such men of technical education, it would not be possible for a mechanic to build such a work as the South Chicago Mills. We might go further and see the great power houses that are being built about the country; they could not be designed by a mechanic, they are designed by technical graduates who are engineers, and it is a strange thing to me that Mr. Crane, of all men, would object to the men who are making more business for him than any others. Take all the fittings and pipes and valves and things of that kind used in power houses, I venture to say that a majority of the work that is being made for Mr. Crane's company comes from the design and work of technical engineers. Take the water works of the country, the engineers who have designed our great water works; Mr. Holman, who has just been elected President of the American Society of Mechanical Engineers; if he had gone to the trade school only instead of Washington University I doubt very much if he would have been put on the Commission to design the Cincinnati Water Works, the Omaha Water Works and the Denver Water Works, and would not have been able to carry out the plans for those great works which are consuming such large quantities of pipes and valves and things which Mr. Crane is making. That is the reason I say, I do not understand why he should object to the technical graduate and engineer.

I think, as I said, that the subject is confused. There is a place

for trade schools and a place for manual training schools and a large place for the technical college, and the technical engineer.

MR. MCEACHREN: As the reader of this paper, I wish to say, I may not have read distinctly enough this part of the paper. "I assume that in asking this you understand that I treat technical education as a means of making mechanics, and that any criticism I may make is not intended to apply to such lines of special training as are necessary for the electrician, the civil or mining engineer, the chemist or the teacher."

MR. FORSYTH: I noticed that part particularly, and the mechanical engineer is not mentioned. He is the man I am referring to.

MR. H. T. BENTLEY (C. & N. W. Ry.): I have listened to the paper by Mr. Crane, and cannot entirely agree with him in all he has to say on the subject of the technically educated man. My experience, extending over a period of years, has been to the effect that technical graduates average up with the man who has not had the benefits of that kind of education.

In the locomotive engineering world it has been my pleasure to know, personally, a number of men who are graduates of technical schools, and who certainly have made as great a success of their particular calling as any men that I know of, not having had the opportunities these men had in the direction mentioned.

On our own road we have had such men as W. H. Marshall, E. M. Herr and G. R. Henderson, who are known by everybody as being foremost in their line in the engineering world. I have in mind dozens of others who have been equally successful. Of course, I fully realize that there are thousands of men who have made their mark in the world that did not have the benefits that these men received, and have been shining examples of what pluck, energy, push and ambition will do.

To broadly say that all technically educated men are failures is just as wrong as to say that all men who have not had a college education are failures. It all depends on the man. Give a man the ambition and perseverance and he will come to the surface, wherever put, irrespective of whether he has a technical education or not. On the other hand, I believe that if a man has the above attributes, a technical education will help him, but again, all of the education that a man may get will not benefit him one bit, unless he has the faculty of using it to good advantage.

The young man who goes to college and has funds provided him for his education, may not turn out a success, but on the other hand, where a man has ambition enough to work his way through college, for the purpose of obtaining more information than he could get at a graded or high school, it shows that he is made of the right stuff, and will, generally speaking, succeed in whatever line of work he undertakes.

The technical schools of this country have been doing wonderful

work, and the character of the work is improving every year. Take for instance, Purdue University, and Professor Goss: This school has turned out a large number of men who are holding prominent positions now, and it would be a sorry day for this country when such grand work as has been done there should be stopped, because some men have not turned out successful.

Look at the thousands of young men we know who have had an ordinary training, who have succeeded in getting to the top of the ladder, and how many with good opportunities have failed miserably. If it is not in the man, you cannot get it out of him either by technical education or by manual training schools.

Mr. T. H. Zealand (Whiting Foundry Equipment Co.):

Mr. President: In the shops and store yards of the Crane Company are a number of traveling bridge cranes which were paid for with good honest dollars. I would like to ask Mr. Crane if he would care to feel that the stresses in the girders and the girder sections had been guessed at. These cranes were designed by a young man who received his technical training at the University of Michigan.

For several days I have been busy designing a 300-ton turntable 85 feet long to be used for turning Mallet compounds. Do you gentlemen believe that the railroad company would care to feel that the stresses and girder sections have been guessed at in this case? This is purely mechanical engineering.

Mr. C. A. Schroyer (C. & N .W. Ry.): I would like to have a word to say on this subject. I am not a technical man, having left a journeyman's position a good many years ago and sat down on a tool box to learn to do car work at $1.50 per day. I often regret that I have not had a technical education and frequently feel the need of it. So far as the point that has just now been made by the gentleman is concerned I want to say to you that you can get a man for $75.00 a month to figure out those stresses for you at any time and all the time, when he does not know a single thing about the principles that are involved.

Now, when it comes down to an apprentice and what an apprentice will make, it all depends on the gray matter in his brain. I can point in this room now to some of the finest technical men that we have in this country, that do not make a success in mechanical lines simply because they do not have the mechanical turn of mind. But they make first class newspaper men, first class professors of colleges, first class men in all pursuits of life, and all are better and more valuable men because of their technical education. I can point out to you other men with a technical education, who, having with it a mechanical turn of mind, have attained the greatest success because of a combination of the two, and in all cases you will see men of this kind mounting the ladder to the very topmost round. They have obtained positions as managers, and at the heads of the largest manufacturing institutions of this country.

While I will say frankly that the loss of a technical education is a great handicap to the man that has the mechanical turn of mind, yet if they have either one or the other, I will take the man every time that has the mechanical ability, instead of the technical man without the mechanical turn of mind. But when you have a good combination of the two, then you have found the boy who will make the man.

Now, I can see a vast difference between things in the shop to-day from what they were when I was a young man first going into my apprenticeship. I served a five years apprenticeship without receiving a cent of compensation. After I was through with that apprenticeship and had worked at that trade for two years, I worked at car building at $1.50 a day, and I can see the difference in things now from what they were then. At that time in the works where I was employed they took in about six apprentices each spring. They were first put in the drafting room for a certain length of time, then in the cabinet shop, then down in the truck shop, then into the freight car department and then in the passenger car department, where they ended their apprenticeship. Some of these boys still retain their positions as mechanics in the shops where they served their apprenticeship. Others have gone out into the world and are now filling positions of trust on many of the most important railroads in this country.

The tendency in our work to-day is towards classification of work, whereby we can keep a man on a certain thing and in so doing we can educate him quickly and we can obtain the best results in the work that he is performing. Now, we cannot take a boy into a department of railroading to-day and put him down and teach him all the branches of work as they did when I was a boy. The first job I ever did was to sit down on a tool box at the side of a car and take out a pair of wheels. That was the first job I had to do. But you cannot get boys to-day with a technical education to do these things. When we have a boy with a technical education he wants to be a special apprentice and he wants to get about as much when he starts as the mechanic does when he ends, and the result is we are not getting that class of men in the car department to-day, because the compensation afforded at starting is not sufficient for them and for that reason they do not want to come. Another reason is because they do not want to put on overalls and get down under a car because of the dirt attached to it, and so it goes all the way down through the line of a railroad institution,

Who are the men that are coming to the front in the last few years? They are the young men with the technical education that have the mechanical turn of mind. They will enter the shops as special apprentices, and you know and I know and every other man who employes apprentice boys knows, that the thought he has in mind when the boy goes to work is that he is going a make a

good foreman, or a good manager of men. Now, I want to say to you again that I have known the very best kind of foremen that have never even learned the trade they work at; they just picked it up and they make good managers of men and they make good men in the positions they occupy. But that applies all along the line. It is in the boy, and the boy with the technical education should not for a moment think that his acquirement in that direction is going to make a mechanic of him, but if he has the education with the mechanical turn of mind, that is the boy you are looking for, and that is the boy who is going to make the man.

Mr. J. F. DeVoy (C. M. & St. P. Ry.): This paper has been pretty hard on the technical man, and I want to say to him, that the only thing the matter is that you have not nerve enough. You do not dare to say it, and I am going to say it for you. I want to quote from a man whom I have worked with for seven years, and a man whom I respect as much as any man in the world. Mr. A. E. Manchester made the statement before this Club that "It was hell to be pallbearer at your own funeral." I am not going to be pallbearer at my funeral and I am a technical man.

What is the matter with the American people to-day? Let me ask, what is the matter now that you have all thrown up your hands because you say you are pinched for a little bit of money? It is because you have not nerve enough; you do not dare stand up to-day and say, "Well, we will go out and take a pair of overalls and go to work." I wondered what M. K. Barnum, W. H. Marshall and any number of the technical men that are at the head of the largest institutions are going to do? I thought "Well DeVoy, you had better start a milk route." I thought, "Marshall, perhaps you had better start a peanut stand, or something of that kind." But in God's name, what does a man who has spent about $4,000, or $1,000 a year on his technical education, want with being a machinist at say $3.75 a day?

The writer of this paper would not run a plant for one minute unless it paid him the interest on every dollar he had invested. Now, I do not want to cast any reflection on him; I respect the man. I have never seen Mr. Crane before, but any man who looks at Mr. Crane need not be told that he makes a success of a thing and that he knows what he is talking about, whether he has a technical education or not.

A technical man will make a success of himself if he has the nerve. I have served my term as a machinist; I have been a piece worker, been all through it, and in my time I have been insulted time and again, but I did not consider it an insult, because, let me tell you, if you will keep at it your time will come. When they tell you that they can hire a man for $75 a month to design a crane, do not let that phase you, because you will never get a job if you do. Because some man tells you when you come out of college, that you

cannot do what is in you, don't you believe him. You are a "quitter" if you do.

What is the reason to-day that the technical men do not want to start as the railroads, the corporations and others want to start them? I know what I am talking about, because I have started many of them and they want him to start in at $50 and $75 a month, while they will take a man that cannot speak the English language and because he has got the pull of some labor union, they will put him in and make an engineer of him at $100 a month. I am not opposed to labor unions, but I am just stating the facts as they are. It has been my privilege for the past seven years to examine nearly every man who has applied for apprenticeship on the St. Paul railroad, and I will say that if the technical institutions are as rotten as some of the grade s chools are, they had better get out of the business, for over fifty per cent of the boys coming out of the grade schools can not pass an examination in common mensuration. Who is to blame for that? I want to tell you that, so far as I am concerned, and with what little technical education I have, I am not going back to the shop and work at $65 a month forever. Don't put me in one place, for I will move on. In other words, if they don't want my cabbages for what I want to sell them for, I will raise better ones next year.

The last speaker is a particular friend of mine. I want to ask him what has brought car designing or car construction to what it is to-day? I want to ask him if he would take the old rule of thumb and carry 5,000 extra pounds in every car around the country, and how in God's name would he find out what it was unless he had a man to design the car for him? You cannot do it; you can talk all you want to. It depends on the man as to whether he will make a success or not. That is the whole thing. Too many of you young fellows sat still to-night and did not talk back for technical education. It is up to you.

A young technical man came to me four years ago and said, "Jim, I want to go in the shop and learn a trade." "My boy, don't you do it," I said. We sat down and I talked with him a little while and there was a proposition put up to him to become foreman of a roundhouse. He said, "I don't how to do it." I said, "I want to ask you one question, is your heart right?" And he said, "You bet it is." I said, "Take the job then, you do not want any trade."

I took the position as a machinist in the Rome Locomotive Works nearly twenty years ago and the only thing I knew about it was what Prof. Lawrence had taught me. That is all I knew about it. I tackled the machinist, and I believe I can tackle him to-day on my own ground. But the young men of to-day have not nerve enough; they have got so scared that they do not know whether to back up or to go ahead. It is the nerve to-day that makes the fellow.

PRESIDENT SELEY: There is a road whose Superintendent of Motive Power came out of the West, where most all good men come from, whose Mechanical Engineer is here. I would like to hear from Mr. Flory about the shop education on the Central of New Jersey.

MR. B. P. FLORY (Central R. R. of N. J.): Something over two years ago the road with which I am connected became convinced that, in order to obtain a better class of men as machinists, it was necessary to do something in regard to their education. We talked the matter over, and thought the best way to do would be to educate the boys coming in as apprentices, giving them instructions during the working hours.

I do not believe it is possible to take apprentices as you find them and depend on them to get the right kind of education out of working hours. A few of them will do it, but there are very many that have other things to do. They want to go downtown, want to go to the theatre, or do something like that. With this in view, in 1905, we established at our shops at Elizabethport a school for apprentices, where they are instructed three times a week, on Mondays, Wednesday and Fridays, directly after the noon hour, the session lasting two hours. There are about sixty apprentices in our shop, and we take twenty in each day in the week, this gives each man two hours instruction per week. What we try to do is to give very practical courses of instruction. We give them problems which they are working on in the shop. We do not go deeply in mathematics or anything like that. We have a whole lot of models and they make free hand sketches from these, and then make drawings from the sketches. The boys are paid their regular rate of wages while in the school.

In starting our school we found that we would have to give some examination in order to get a fair class of apprentices, so now they are examined in reading, writing and arithmetic, and, if they do not pass, we do not take them in. We also found that sometimes after a boy had worked one month or two months, he would quit, so now we establish a probation period of three months, and if the boy shows up well, then we take him on in the instruction class and not before.

Some people may ask, does it pay to do this? Are not we educating apprentices for other roads and other manufacturing establishments? We do not think so. Since 1905, when we established our school, we have had 144 apprentices on our rolls; 21 resigned after serving from one to four months, 8 resigned after four to twelve months, 8 resigned after serving one year, 6 resigned after serving two years, 6 resigned after serving three years, 6 resigned after completing their apprenticeship, and 18 are in service as machinists, they having completed their apprenticeship. Seven were discharged, 7 on the probation period of three months, and 57 now attending school, time not yet completed. The boys who served from one

month to two months resigned because they lived too far from the work or were not strong enough physically and did not care to learn a trade. So that the majority of apprentices were retained in service after completing their apprenticeship, and there is no doubt that the knowledge that they have acquired has helped them considerably in the work, and the company has been materially benefitted from the fact that the young men have taken more interest in this subject and that they do the work more intelligently than it has been done heretofore.

We have found that through instruction the boy in the shop can read drawings, he can get out his work more quickly and we think that altogether we are developing a higher class of machinists and that the road is amply repaid for the time and money it has given for the instruction of these apprentices.

Mr. F. L. Baker: I am a technical man and I wonder if the gentleman was referring to me in what he said about $75 men and formulas and so on. Well, that is very much like it would be with an apprentice; telling him what to do, and the boy may do it, but if you put that same man o nsome entirely new line of work that is not common to the shop in which he is working, he will fall down. You will have to turn to your technically educated man, or the man who knows where formulas come from to see how far he can apply them, and if they do not apply, to find out a formula that will apply.

The $75 man business is a good deal like going to a druggist with a common headache due to a disordered stomach and asking the clerk to give you something that will relieve your pain, and he will give you a patent dope of some kind. Well, that is a doctor's business, but you do not go to a doctor, you go to a cheap druggist clerk. If you have appendicitis, you do not go to a druggist, you go to a high-priced doctor to get your appendix cut out.

I would like to ask why the Pennsylvania Railroad is making such a big demand for technical men. They are writing all over the country and asking for technical men. Certainly they must find them of value, or they would not be asking for them. And I would also like to know—I did not hear anything in Mr. Crane's paper that stated why Mr. Armour put his money into the Armour School of Technology. Certainly that is doing good work and I know some Armour graduates who are doing good work in the engineering field.

I agree with the gentleman to my left in regard to technical men not wanting to go into the shops with only the hope of becoming mechanics at $3.50 a day, when with a very short course in a special apprenticeship they can go into an engineering position which will pay them five or six or ten dollars a day.

There are two classes of college students, and I am afraid that Mr. Crane's experience has been with the first class; those are the boys who are *sent* to college. The second class are the boys who

go to college. They are the boys who have mechanical ability and they are seeking to improve that ability by getting a technical training and go to the technical schools to get it. There is no other way for them to do. Most of those who are in college have gotten beyond the high school, they have gotten beyond the manual training school and where will they get their education? If they have to work and cannot go to college, if they have the right stamina, they will go to the correspondence schools at night (and there are excellent ones, too), and in that way they devote their spare time to study without the loss of time and wages necessary for resident study in college. A young man who will devote his spare time to such study, a man who will not let his social obligations or his social pleasures divert his attention from the principal object of life, has got in him those qualities which will make a successful man of him, whether it be as engineer, money maker, or in whatever line he may choose. My experience with a great number of technical men is this—the boys who are sent to college by rich parents do not show up well; they are sent because their parents do not know what to do with them. The boys who go there on their own effort turn out well. I know lots of boys who have gone through college who waited on the table for their board, who have taken care of furnaces, taken care of horses and have done a variety of things in order to pay for their board and room, just to enable them to get a good technical education, and they are making good in the engineering and business world.

It is some ten years since I was graduated from the University of Michigan. I know very well that although I have not shone very brilliantly in the technical, engineering or business world, I would not be where I am to-day if it were not for my technical education. After leaving school I entered the shop as an apprentice. The time spent in the shop has been most valuable to me and I would advocate for every boy who comes out of the technical school the first thing for him to do is to go to the shop as an apprentice. It gives him special training and experience whereby he can apply the knowledge which he obtained in the college to good advantage. If he is unwilling to put on overalls, and get his hands dirty, then he is unworthy of becoming an engineer. But most technical men hope to become engineers; they do not want to stay back in the shops and become only trained mechanics. There are enough boys who do not have the advantages, who do not have the ability, who have to leave school in the grammar grade; there are enough of those boys to fill the ranks of our mechanics, and I thoroughly agree with Mr. Crane that manual training is the education that they should be given. Catch them when you can, because they are a great deal like fleas, if you do not catch them while they are in school, when they leave school you will never get them and they will deteriorate into the common herd earning a bare existence and keeping the wage scale of the country generally down to a low level.

I think the college men have a place in this world. I heartily agree with Prof. Endsley that the colleges are young; they are beginning to see their errors; they are beginning to see that their courses are not what they should be. The abstract subjects which Mr. Crane read taken from the catalogue of some college that has a series of such subjects, I admit are subjects that are taught in our technical schools, but the boys who are taking them are not those who wish to become mechanical engineers nor electrical engineers; they are the civil engineers, the men who hope to take up geodetic survey, topography, astronomy and work of that character. Those subjects are of value and of very great value in those lines of work; they are not of any special value to the mechanical man, and the mechanical man is not required to study them. A mechanical man is required to study combustion; he is required to study the expansion of steam, the strength and resistance of material, the action of electrical currents, the theory of mechanics and the results produced by the application of mechanical principles. I know that while the schools at the time I left those schools were seeking to improve their men and turn out good men, to-day the same schools are far in advance of what they were then; that the men they turn out are of much greater value to the business world and to the mechanical world.

I am glad that we have technical schools and I hope we will have more of them and I hope they will profit by the ideas that Mr. Crane has advanced and get over some of the school-teacher ideas which they have and be devoted to more practical engineering. There is a wide field for work in that line and much room for improvement, and I think it is coming about; we shall see the day before long when the technical man is just as valuable as the man without a technical education, and a little more so. If we want examples of successful technical men—Mr. Crane quoted in his paper about the Illinois Steel Company. I will admit that the Illinois Steel Company's plant was built by a mechanic, but I was glad to hear Mr. Forsyth speak about the man who designed the works; Mr. Crane omitted that. I wish to say that the Indiana Steel Comapny, another part of the United States steel corporation, is building to-day one of the most magnificent, one of the largest and best equipped modern steel plants in the world, and they are technical men who are doing it.

Mr. W. O. Moody (M. E. Illinois Central R. R.): The widely different results to be observed in men who have received a technical education, can be accounted for under the remarks of Mr. Baker, that two classes of men attend college "One who goes and one who is sent. The one who goes has a natural mechanical inclination, which is a necessary foundation upon which to rear a technical education, producing a successful and capable engineer.

The purely mathematical mind finds a wide scope for operation along mechanical lines, the pleasure being in the solution of the

problems, rather than in their practical application. The greatest engineers are not those who find the keenest pleasure in the solution of problems pertaining to the design, but in the operation of the completed machine. These latter consider their technical training not the end, but simply a means to an end and an intelligent means which is approved by their judgment. That class of men possessed of mechanical ideas of commercial value whc have coupled to this good business ability and enterprise, find the services of men with a technical education necessary to get these ideas on paper, as an important preliminary to manufacture.

The man who is capable of making these necessary calculations is certainly in as favorable position as the average machinist at his trade, considering that each was endowed by nature with equal amounts and quality of ambition.

The modern steam turbine, air navigation, naval gun development and the results obtained by the steam ship Lusitania, can be traced to the man with the education which enabled him to make preliminary calculations for the practical results obtained, and although these same men, possibly, could not conduct a profitable business, their efforts were valuable to others and the world at large. The man with a knowledge of calculus will solve a certain class of problems in less time than another man would spend in discovering a solution within the compass of his knowledge.

A man mentally fitted by nature for organization, system and maintenance of standards, will not find this part of his being stunted by a technical training, although shop experience will foster his judgment. Many men are so endowed that they can correct the evils existing in a machine, but without the talent to get it in workable shape on the drawing board. It is hoped that such discussion will not widen the breach between the practical trained and college trained man, as each can and should receive from the other.

President Seley: Gentlemen, is there any further discussion before we ask Mr. Crane to close the subject?

Mr. T. S. Reilley: Before Mr. Crane closes, will he tell us if he has anything in the apprenticeship training line in his works, anything for the boys after they graduate from his schools and go into his works?

Mr. W. E. Symons: Many of us are creatures of circumstance, and most all of us are the product of our environment, which is usually reflected by the utterances of writers and public speakers. Mr. Crane's paper this evening very clearly reflects his environment from boyhood until the present day, and I feel safe in saying without fear of contradiction that no one can criticise or dispute any of his statements with respect to his method or formula for producing a first class business man and a good citizen of a community, or a good mechanic. The term "Technical Man," however, is not infrequently very ambiguous in the strictest literal sense,

and a man who is essentially technical is not much in demand, while engineers and broad gauged scientific men are not only in demand at all times, but they are invariably practical if they are successful. No less an authority than Mr. Tratwine and other equally eminent engineers are authority for the statement, that the qualifications of good mathematicians and good engineers are rarely combined in one person; that even though a man may receive mathematical training of a high order in early youth, yet later on in life in its application, as he becomes practical in the art of applying the forces of nature to the uses of man, he must necessarily forget much of the details he learned at college in order to make room for more weighty subjects in connection with great engineering projects, essential in the career of a successful engineer or business man. Nature has been very kind to Mr. Crane, in that, of his entire equipment, strong force of character, a very happy temperament, together with an excellent physique predominating to such an extent that even had he been less favored—from an educational standpoint, his success would have been equally as marked. This is not true with a large majority of the human family; many of them must have 90 per cent education in order to succeed. Had Mr. Crane's experience been in the railway and similar lines rather than the manufacturing, I am inclined to think it is not improbable that as the result of his experience in handling men, his views as to the proper treatment of apprentice boys and young mechanics might possibly have been a little different from what it is. The apprentice boy years ago was entirely a different proposition from at present, for the reason, that in recent years they have almost invariably found themselves, as it were, between the upper and lower mill stone and were forced to either ally themselves with labor organidations, or incur the enmity of the mechanics or journeymen from whom they would naturally expect to learn the art; this, together with the fact, that they were constantly working with, and usually living in the homes with the men who composed these labor organizations, they naturally allied themselves with them, with the result, that much of their time has been spent in discussing problems before labor organizations when they really should have been attending some night school with a view of improving their education, so as to fit themselves for advancement later on in life.

Therefore, while it seems clear to me that the object set out by those who favor technical education, who have spoken here this evening, and by Mr. Crane is precisely the same, yet the fact that each recommends a method of procedure entirely different from the other, reflects his environment rather than serving as a condemnation of either. Each is taking a little different course, but with the same ultimate object in view, and it would appear to some who have combined theory with practice that a happy medium between these would be a reasonable safe and conservative course to follow.

We can all, however, regardless of whether our experience may have been in the manufacturing line or railroad line, whether we may have graduated from a technical school, a work shop of experience, or a happy combination of the two, we may well and safely follow the advice and try to emulate the example of a man who came to the city in early boyhood, and with practically no means, has worked his way to fame and fortune and is now possibly doing more for the welfare of mankind in general than any other man of his means.

With reference to Mr. Carnegie, to whom much credit is due for his assistance in all educational lines, it would seem at first blush that Mr. Crane's suggestion, that Mr. Cargenie might have well dumped his 12,000,000 dollars with another 12,000,000 dollars into the sea, might be taken seriously, but when we reflect that Mr. Carnegie is a very smart, shrewd, far-seeing business man, we may detect method in his madness. He has never been accused of overlooking a bet in a business transaction, and while it is true that the sum total of the utterances in his book are complimentary to practical men, yet we must not forget that Mr. Carnegie is still in the steel business, and that the most of steel products is bought by rich men, who, if they have sons, send them to college, and it is, therefore, not improper to reason, that Mr. Carnegie may have figured it out, that by endowing colleges with his money, he might advertise the Carnegie steel, while if he should get in the habit of dumping money in the sea, about $24,000,000 dollars at a time, the probabilities are that he would be hustled off to an asylum and conservators appointed for his business.

President Seley: Mr. Crane, will you kindly close the discussion?

Mr. Crane: There is another feature of this technical question that I have not referred to and it consists of a series of experiences that I have had with technical men, and which has led me to feel as I have practically expressed myself, but as I do not seem to have convinced some of these technical men here on the subject, I wish to read another paper giving my experiences which to my knowledge clearly proves most decidedly that there is something about the technical man that education unfits him for any business activity. Now, that is pretty strong language, but I think my paper proves it.

I will answer Mr. Forsyth here that the mills that I had in mind and that I had reference to were built before the South Chicago mills. The plant I referred to was built on the North Side and I take it that was before Mr. Forsyth's time.

I do not think there is anything else I want to speak of, except to thank you, and I will have the paper read.

Mr. McEachren: The number of instances Mr. Crane has jotted down regarding the technically educated man are:

CHICAGO SEWER SYSTEM.

Many years ago Chicago was very seriously troubled by pressure of the gas in the sewer system, it being sufficient in many cases to force the gas into houses through the sewer-traps. The city engineer finally took up this matter and recommended the present system, which is to have the manhole covers with open work, so as to allow the sewer-gas to escape into the streets.

I immediately noticed that this seemed to be a defective plan owing to the fact that the sewer-gas escaping all over the streets on the surface of the ground was likely to come into dangerous proximity to the public, and I argued that, so far as the health of the people is concerned, we might as well have the sewers run in the gutters along the streets,—that that would be no more detrimental than to have the gas escaping through the manhole covers.

I recommended that the pressures be taken off by flues running up along side the chimneys in public buildings, which would have the effect of discharging the gas at a very much higher point and where it would be diffused and consequently less detrimental to health than under the present system. The city engineer who had this matter in charge took offense at my suggestions and scolded about it and went on doing the work as he had started out. I was so fully convinced that I was right on the subject that I had such a flue as I have mentioned put in at the police station on Desplaines Street, between Lake and Randolph Streets, at my own expense, to demonstrate the correctness of my plan. As the city is continually putting up police stations, engine houses, school houses, etc., these flues could have been put in at very little expense. Undoubtedly it would have cost no more to do this than to put in the manhole covers.

This educated engineer, however, either had not the courage to admit he was wrong about this matter, or the good sense to see the correctness of my position.

ELEVATOR INVESTIGATION—CENTRAL MUSIC HALL.

At a very early stage in the elevator business and when the Chicago Central Music Hall was being built, the merits of passenger elevators had not been very closely settled, and the committee on buildings thought it was of sufficient importance to appoint a commission to look into it. They therefore appointed for this purpose three of the very best engineers in the city. They investigated both our machine and that of our principal competitor thoroughly, and up to a certain point nothing developed to show that one machine had any particular advantage over the other. But towards the close of the investigation this competitor's elevator was put to a certain test which showed it was decidedly defective. This, of course, ought to have given us a decided victory, but the committee, instead of giving the straight facts and awarding us the preference, which we

were absolutely and clearly entitled to receive, turned around and made the statement in their report that, if our competitor would make certain changes in his machine, it would be a better machine than ours. The absurdity of such a report must be perfectly apparent to any reasonable person, for the experts had no right to make any suggestion as to change in the construction of the machine. I would further say that there was nothing to justify such an assertion, for even if our competitor had made the changes suggested by the committee, our machine was the superior, as time has proved to be the case. Through this absolutely stupid conduct on the part of the committee we were deprived of a very valuable decision. However, the building committee of the Central Music Hall, having the matter in charge, saw the gross injustice of this report, and gave us the contract in spite of it.

GOVERNMENT'S INVESTIGATION OF ELEVATORS.

Many years ago the Government appointed a commission of three men (either from the navy, or the army, or both) to investigate the subject of elevators, so that they might have something which would be a guide when considering the question of elevators for the various buildings they were continually putting up. At that time we had as a competitor in this line the same concern that I have referred to in connection with the inspection of elevators in the Central Music Hall. This commission simply examined our competitor's elevator, ignoring ours as well as all others; they incorporated his statements in their report to the government and recommended his machinery. This report contained a certain amount of facts and peculiarities that were combined in his machine, none of which, however, made it better than other machines, and they put in a good many other facts about things connected with his machine that were identical with other machines; in other words, their report was an absolute fraud. After the government's architect had been governed by this report for a number of years, I took it upon myself to go before the Secretary of the Treasury and show the matter up. He practically admitted that it was a fraud, and the supervising architect was then obliged to change his methods.

There are two inferences to be drawn from this case. Either the committee was absolutely dishonest in investigating but one machine, or it had not enough sense and enterprise to carry out the work for which it was appointed.

ACCIDENT TO ELEVATOR IN AMERICAN TRACT SOCIETY BUILDING, NEW YORK CITY.

Several years ago, quite a serious accident occurred with a new type of elevator that we had placed in the building of the American Tract Society in New York City, and a committee, consisting of three of the very best engineers in that city, was appointed to investigate

the case and make a report. At first I thought I would not go down there myself, and sent one of our engineers, but afterwards I decided to go, as I feared that some blunder might be made in the committee's report. Before I got to New York, I made up my mind as to the cause of the accident, and immediately upon my arrival I met the architect and the Tract Society people and said to them that, no matter what the committee might say in its report, I was convinced that I knew the cause of the accident, and requested that I be allowed to go ahead as quickly as possible and make arrangements to prevent its recurrence, which privilege was granted.

I then called on the engineer who had charge of drawing up the report, and told him that I did not know what their theory was as to the cause of the accident, but that I was confident it was caused by certain defects in the arrangement of the apparatus, and that I had arranged to have the job changed over so as to avoid a recurrence of such an accident.

I do not know what their idea was as to the cause of this accident, but this engineer, who was a fine, manly person, had the honesty and decency to say that no one was more free to correct any mistakes he might make than he was, which of course was an admission that he had made a mistake in the matter and was going to correct it. My theory of this case is that the engineers in question had not investigated with sufficient thoroughness to get at the bottom of the matter and were about to make an incorrect report.

ELEVATOR WITHOUT COUNTER WEIGHTING.

When we were in the elevator business we at one time had in our employ a young man who was a graduate of a scientific school. He was the son of one of the old-fashioned practical and successful men. We were experimenting with a new kind of elevator and had put up several of them. Finally we had quite an important job, where the architect wanted that kind of an elevator, and it was concluded in this part of our business to make a change in the general arrangement of the machinery. Plans were made and the machines were finally built and placed in the building. It was a particularly important case, as the building had been delayed through various causes and a failure to have the machines start up as soon as the building was completed would cause serious losses. I had therefore cautioned this man repeatedly to be very sure there was no mistake in this matter, and he assured me that he had done so and that there was no question about it.

Finally, when the time came to start the machinery, we discovered that it would not lift a pound. He had entirely overlooked the counter weighting, which was a tremendous item in the calculations. This was not only a blunder on the part of the man mentioned above, but also of the man in the drafting-room, who ought to have seen the defect.

STEEL FURNACE FOR PRODUCING STEEL CASTINGS.

On this line of work we engaged a scientific metallurgical expert who claimed to have a thorough knowledge of what was needed to give us the metal we required. He went to work and put up a furnace and spent about $15,000, but when he came to operate it he did not seem to get any kind of results, and then, after he had made a failure of it, he said, "I did not understand what you wanted me to do."

PIPE MILL.

Many years ago I employed an expert to assist me in building a pipe mill. Not only was he an expert, but he had had a large amount of practical experience in pipe manufacturing to make him qualified to furnish this work for which I had employed him.

In building the mill, the first and most important question to determine was the style of welding furnace. At that time there was a variety of furnaces used, but we had concluded that we wanted a gas furnace if possible. The Seamen furnace, which was a great success, was owned by people who had the exclusive right to it, and so we could not use that. But there was a party in this country who had a French furnace that was a rival to the Seamen furnace and was thought to be about as good.

I sent this expert to see this furnace and he pronounced it all right, but as it was a very expensive and important part of the plant, I concluded that I had rather have the furnace passed upon by some other experts in order to make sure there should be no mistake about it, and I engaged two men in New York, who were supposed to be authorities in such matters, to look at it, and they pronounced it all right.

I then contracted for one of these furnaces and had it put up at a large expense and it proved a great failure. The oversight on the part of these experts seemed to be that, while the furnace would get up a welding heat, it did not have the capacity for producing heat rapidly enough to make it successful. So we see that two sets of experts blundered in this matter, but my original expert in continuing his work made blunder after blunder, and they grew mainly out of the fact that he wanted to get up something more on the scientific order, and while he had used simple and thoroughly practical things in his former position that did the work with the greatest perfection, he was never satisfied to adopt these, but must have something, as I have said before, on the scientific order, resulting in failure after failure. I got no results out of this mill until I dropped this expert and got hold of a simple, practical workman. He straightened out one thing after another and finally got a successful mill.

MANUFACTURERS' SONS.

I knew a manufacturer in Chicago who was doing business here when I first came to the city. He was an old-fashioned man, a good

mechanic, thoroughly honest, had a good reputation and built up a very successful business. As he got along in years, he concluded that he had all the money he needed (which was not a great deal), and decided to retire from business and turn it over to his three sons, who had been to scientific schools and had received every opportunity, so the father thought, so far as an education, either scientific or otherwise was concerned, to qualify them for business. He got the notion into his head, like many other people do, that if he sent his boys to one of these schools they would be able to conduct the business better than he had done, but as a matter of fact they turned out to be absolute failures, being utterly impractical and unable to conduct the business after it was built up for them in the manner I have mentioned.

GAUGES.

Some years ago the pipe manufacturers in this country discovered that their gauges had become very irregular, and concluded to correct the irregularities. So they went to the Pratt & Whitney Co. and asked that concern to send them an expert to take this matter in hand, which they did, and all makers were requested to send their sizes, in order that he might compare them and report just where everybody stood. When he came to make his report to the manufacturers it was discovered that there were some sizes on which there was quite a wide variation in the gauges.

Now, the fact of the gauge being of a partiuclar size is not at all essential. The only matter in this case was to see that all had the same gauge. I took the matter up myself with the expert and endeavored to impress upon him this fact, and the way to go about it to make these corrections was to take all the sizes and establish a new gauge which would be a compromise of all the variations of the manufacturers, in order that the manufacturers would get to a new gauge with the least possible trouble to the trade and in the shortest period; but I was unable to make him see the point. The result was that the manufacturers had to go to the extreme in correcting this thing.

In order that you may appreciate the importance of conducting this matter in the way I have mentioned, it would be understood that the trouble was not only with the pipe, but also with the fittings. There were hundreds and hundreds of tons of fittings scattered all over the country which had been made according to the old gauges, and it would take a long time for the people to get them worked off before they mixed up their stock with fittings made according to the new gauge, and to go from one extreme to the other, as this expert wanted them to do, meant a long drawn out annoyance.

DRAUGHTSMEN.

In our draughting room some years ago we had a scientifically educated German. He was put on a job of designing a special machine for our superintendent, and there was a feature of it that required a rather nice piece of mechanism. He figured it out theoretically, and, to my surprise, had it about correct. But as there were quite a number of other pieces of the same kind of work that had to be worked out, and they all varied a little, it seemed like a slow and rather uncertain method of going about it. So I looked into the matter myself, and discovered a direct, quick and certain way, which we followed with perfect results.

I simply speak of this to show that such men can never see a straight-forward way of going about a piece of work, but must go at it in some mysterious, scientific round-about way.

ARCHITECT.

I employed an architect some years ago to prepare plans for a building. In this line of work the technical engineer came in to plan the engineering part of the building. When the architect submitted his plans for the foundations for the columns it struck me that they were very much too large, but when I told him so he did not seem to be disposed to question the correctness of his engineer's calculations. I then had the foundations examined in another building used for a similar purpose, which demonstrated that the ones called for in the architect's plans were fully twice as large as there was any occasion for.

I then insisted upon the architect cutting them down one-half, notwithstanding his protest, and today the foundations seem to be amply sufficient, whereas the timbering of the building is very deficient, showing that he had his foundations more than double the strength required for the loads and the timbering was not as strong as it ought to be by probably a third.

In the old building to which I have referred, and other buildings that were put up by the old-time architects before the engineer came into the field, the foundations were apparently correct for the strength required and harmonized with the strength of the timbering.

DOCKS AT LAKE GENEVA.

At Lake Geneva, ever since steamers have been used there, it has been the custom of every one to build small light docks, which were in every way practical and answered the purpose. Some years ago, when the C. & N. W. Ry. finished their road to the lake shore, they concluded to build some docks for the public, so they brought in men whom I presume were their expert engineers, who, instead of following the general custom at the lake, started in to drive down great piles and lay enormous timbers which were about two feet

too high, and were strong enough for the handling of coal or pig iron, besides being very inconvenient. But this was not the worst part of it. Some years later, finding that there were a great many naphtha launches on the lake, they thought they would build a smaller dock to accommodate them. They started in to build a lower dock, which of course was more convenient, but, to my surprise, they went to driving piles for this also and made it about as strong as the one for the large boats,—in fact, as in the other cases, it was strong enough on which to load pig iron.

After these instances of my experience with technically educated men,—do you wonder that I regard the subject as I do?

Mr. A. E. Manchester (C. M. & St. P. Ry.): We occasionally have a meeting of the Western Railway Club that "stirs up the animals," and I am glad to see that the paper we have had tonight has been one of those, and I move that we tender a vote of thanks to Mr. Crane for his very interesting and valuable paper.

Mr. DeVoy: I would ask the privilege of seconding that motion and my reasons for doing so are these,—no matter what a technical man thinks, that paper has been, in my opinion, one of the best I have ever listened to, and no matter how diverse our opinions may be, we must wake up to the fact that there is something the matter with us and there is not anything I have ever heard that has brought it out any better than this paper has, and I believe that we are indebted to Mr. Crane to that extent and I ask the privilege of seconding the motion.

Mr. Schroyer: I want also to second that motion and just to say in explanation of those cases that have just been read, that that was a case of a good mechanical guesser pitted against a poor technical figurer.

I had several cases of that kind come under my observation. There was a vacuum system of ventilation put into our blacksmith shops for carrying out the gas and smoke. It was put in under a certain agreement that required it to perform a certain amount of work. The payment was to be subject to the condition of the job and it must be satisfactory. The job was completed and the blacksmith shop was started up, but the system failed to carry off the gas and the smoke. Every engineer that was employed by that concern,—and it was one of the largest in this country,—visited our shops a number of times, covering a period of six months. The pipes led from the furnace and the forges up into the comb of the roof where the motor and the fan were located and the gas and smoke were forced out on the top of the roof through the loovers but they could not tell what was the trouble with the thing. We were holding up payment on the job for six months or more. Finally our machinist said to one of their engineers that came up to see it, "I will tell you what is the trouble with the machine; your fan is running hind-end foremost." And in fact it was. Now, the trouble with that was

this; the technical man who laid out that thing failed to specify clearly on the blue prints from which it was applied that, "Care must be exercised to see that the fan revolves in the right direction." (Laughter.)

PRESIDENT SELEY: It has been very ably moved and extensively seconded that we tender a vote of thanks to Mr. Crane for his paper of the evening. All in favor please say aye.

Motion carried.

PRESIDENT SELEY: Mr. Crane, you will please accept our thanks.

We have another paper scheduled for tonight entitled "Ventilation and Heating of Coaches and Sleeping Cars," by Mr. Sam'l G. Thompson, Asst. Engr. Motive Power, Penn. R. R. Co., but owing to the lateness of the hour, I believe it will be well to defer it until our January meeting. A motion to adjourn will be in order.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, January 21, 1908. President C. A. Seley in the chair. The meeting was called to order by the President at 8:08 P. M. The following members registered:

Adams, C. E.
Albert, C. J.
Alsdorf, R. C.
Anderson, E. C.
Arlein, A. J.
Axtell, G. G.
Baird, Wm.
Barbee, D. C.
Barber, J. C.
Barber, L. W.
Barnes, C. A.
Barnum, M. K.
Barton, T. F.
Beland, Geo.
Benedixen, J. H.
Benson, R. W.
Borrowdale, J. M.
Bourne, G. L.
Brady, D. M.
Brown, G. H.
Bryant, G. H.
Buell, D. C.
Bundy, C. L.
Bush, S. P.
Callahan, J. P.
Carlton, L. M.
Carman, C. H.
Carney, J. A.
Carroll, J. T.
Christenson, A.
Clark, F. H.
Cody, P. C.
Cooledge, F. J.
Cota, A. J.
Cramm, T. B.
Crownover, G. M.
Cudworth, H. N.
Dabrowski, L. V.
Darby, I. W.
DeGroot, E. H. Jr.
DeVoy, J. F.
Dickinson, F. T.
Dietrich, J.
Dodds, E. I.
Dow, G. N.
Downer, E.
Endsley, L. E.
Estrup, H. H.
Fantom, W. F.
Feldhake, J. M.
Fenn, F. D.
Fitzmorris, Jas.
Fogg, J. W.
Forbes, R. C.
Ford, J. M.
Forsyth, Geo.
Fowler, G. L.
Fowler, W. E. Jr.
Frey, N.
Fry, C. H.
Gale, W. T.
Garrett, M. A.
Goodwin, Geo. S.
Hanchon, B. F.
Hahn, F. W.
Haig, M. H.
Harkness, F. L.
Hamilton, J. R.
Haynes, J. R.
Henderson, Thos. D.
Hildreth, F. F.
Hopkins, Geo. H.
Hungerford, W. R.
Hunter, P.
Isbester, Geo. C.
Jeffries, B. H.
Jenks, C. D.
Jett, E. E.
Jones, L. E.
Jones, M. T.
Keeler, Sanford
Kelley, H. D.
Kroehler, F.
Kucher, T. N.
LaBach, P. M.
Lee, E. H.
Lewis, J. H.
Lickey, T. G.
Little, J. C.
Loomis, H. N.

Lovell, C. P.	Peters, H. W.	Tawse, W. G.
Lowder, R. S.	Peterson, C. H.	Taylor, J. W.
McAlpine, A. R.	Pratt, E. W.	Templeton, W. B.
Macpherson, A. F.	Price, R. C.	Tetlow, E. W.
Manchester, A. E.	Raidler, W. P.	Thomas, C. W.
Meyer, E. J.	Ralston, C. A.	Towsley, C. A.
Michael, L. P.	Roope, T.	Tratman, E. E. R.
Midgley, S. W.	Rosser, W. W.	True, C. H.
Milner, J. T.	Rowley, S. T.	Vincent, M. M.
Mitchell, J. H.	Ryder, G. E.	Walbank, R. T.
Mohle, C. E.	Schroyer, C. A.	Walker, E. H.
Morrison, F. A.	Schroyer, H. H.	Wear, D. W.
Moskowitz, M.	Seley, C. A.	Webb, E. W.
Motherwell, J. W.	Sharp, W. E.	Willcoxson, W. G.
Murphy, E. L.	Slibeck, J. G.	Woods, J. L.
Nathan, C. A.	Smith, W. R.	Woods, E. S.
Neff, J. P.	Stone, Geo. A.	Wright, Wm.
O'Rourke, J.	Stott, A. J.	Wunderlick, W. E.
Peck, C.	Sullivan, C. L.	Young, C. B.
Peck, P. H.	Sweringen, F. H.	Zealand, T. H.
Penner, Carl	Symons, W. E.	

THE PRESIDENT: The meeting will please come to order. We are eight minutes late on our schedule.

The first in order will be the approval of the minutes of the last meeting. As these have been printed and distributed, they will be approved, unless there are omissions or objections. There being none, they are approved. We will now have the report of the Secretary.

THE SECRETARY: Mr. President, I have the usual membership statement.

Membership, December 1907		1,437
Resigned		8
		1,429
New members approved by Board of Directors	10	
Reinstated	1	
		11
Total membership		1,440

Name	Occupation	Address	Proposed by

G. A. Schneider, Standard Steel Car Co., Hammond, Ind. . W. A. Libkeman
A. W. Adams, Allen & Morrison Brake Shoe Co., Chicago. . G. N. Sweringen
E. W. Webb, M. E. Standard Car Truck Co., Chicago, Ill. . . Lee W. Barber
F. T. Dickinson, Amer. Brake Shoe Fdy. Co., Chicago, Ill. . C. L. Sullivan
D. M. Brady, Prest. Brady Brass Co., New York, N. Y. . . G. H. Bryant
L. I. Yeomans, Insp. Armour & Co., Chicago, Ill. . . . . W. E. Sharp
W. B. Moulton, Insp. C. M. & St. P. Ry., Evanston, Ill. . . . J. P. Neff
E. L. Gibbs, Inspector Interstate Commerce Commission, Ft. Worth, Tex. . . . . D. C. Buell
C. B. Hoyt, Supt. Track Maintenance & Construction, N. Y., C. & St. L. Ry., Bellevue, Ohio . . . . G. N. Dow
A. W. Bowman, Gen'l Yard Master, C. & E. I. R. R., Chicago, Ill. . . . . F. H. Rutherford

REINSTATED.

A. M. Smith, Detroit, Mich.

RESIGNATIONS.

Jas. G. Mowry, Patton Paint Co., Newark, N. J.
J. D. Young, Mach. Shop Foreman, C. B. & Q. Ry., Havelock, Neb.
G. A. Richardson, C. M. & St. P. Ry., Chicago, Ill.
B. J. Sweatt, C. & N. W. Ry., Boone, Ia.
F. M. Gilpin, Latrobe Steel Coupler Co., Chicago.
Geo. Ackerman, Solid Steel Tool & Forge Co., Chicago, Ill.
C. C. Winegardner, L. S. & M. S. Ry., Elkhart, Ind.
J. A. Mullin, C. & N. W. Ry., Norfolk, Neb.

Mr. President, I have the following communication:

The Trustees,
the President and the Faculty of the
University of Illinois
cordially invite you to send a
representative to the installation of
William F. M. Goss, D. Eng.
as
Dean of the College of Engineering
on Wednesday, February the fifth
nineteen hundred and eight,
Urbana, Illinois.

The Board of Directors at its meeting this evening named Mr. F. H. Clark, General Superintendent of Motive Power of the Burlington, to represent the Western Railway Club at this function. I have no doubt Prof. Goss will be pleased to see as many of the members of the Western Railway Club as can be present.

Mr. President, those are all the communications I have.

The President: I am very glad to see so large a number present at this early hour of opening. We have a great deal to do this evening, having the consideration of two important papers, which will take all the usual time of the meeting.

It has been said, "Once a railroad man, always a railroad man." The writer of the first paper to be considered this evening and which is entitled "The Car Wheel and Its Relation to the Rail and Car," is not now a railroad man. He is a business man, but I can assure you that he will make a noise like a railroad man. The supply fraternity gained when Mr. S. P. Bush joined their ranks and the railroads lost a man who still enjoys a very large measure of our respect and esteem. This Club is particularly fortunate in having Mr. Bush enrolled in its membership and I now take pleasure in asking your attention to his paper.

Mr. S. P. Bush (Buckeye Steel Castings Co.): Mr. President and Gentlemen of the Western Railway Club: I certainly appreciate the introduction of the President. I can honestly say that it is a very great pleasure for me to meet you again this evening. It has been pretty nearly eight years since I left the railway service, and Mr. Seley

states truthfully when he says "once a railroad man, always a railroad man." I can say to you honestly to-day that my interests are absolutely, and my sympathies are absolutely, with the railroads. I sympathize with them in their struggles at the present hour, and I hope that if they succeed in getting out of their troubles, they will not get into them again.

I have selected as the subject of my paper "The Car Wheel and Its Relation to the Rail and Car," and I have endeavored to make it as short as possible. I might have said a great deal more, but I realized this, that railroad men like to get down to the substance of anything as soon as possible and I tried to eliminate all that was superfluous. although it will be necessary at times for me to introduce, extemporaneously, a few thoughts that have come to me since I have written this paper.

THE CAR WHEEL AND ITS RELATION TO THE RAIL AND CAR.

By Mr. S. P. Bush, Genl. Mgr. Buckeye Steel Castings Co., Columbus, Ohio.

The failure of car wheels under the heavier service of the last few years and the removal from service of a larger number that might with reasonable certainty have failed, together with a much shorter average life of car wheels on many of the railroads of the country, have brought the wheel question sharply to the attention of railways and the wheel manufacturers. It is a problem of general interest, not alone because of the item of safety, but also because of the pecuniary question involved and is a matter of great importance at this time when the cost of railway operation is tending heavily upward.

It is not my purpose to enter into a highly theoretical discussion of the subject, for I am sure such would be tiresome. It is not my belief, either, that I am presenting much that is new to members of this Club or to the railway world, but on the contrary I expect only to present some facts already established, together with some explanations, in a simple and concrete manner, with the hope that discussion will follow which may lead in a direction in which the writer believes there is opportunity for satisfactory development.

To commence with, it may be well to consider some facts concerning the car wheel and the conditions under which it has operated in the past and is operating at the present time, and to this end I present the following:

In going back to the period of the 24,000 pound capacity car, and comparing with the present 100,000 pound capacity car, the increase in load capacity, formerly 24,000 pounds, now 100,000 pounds capacity, is 76,000 pounds. Increase in tare weight formerly 18,000 pounds, now 42,000, is 24,000 pounds. Increase in permit-

ted excess load 10 per cent, formerly 2,400 pounds, now 10,000 pounds, or 7,600 pounds, making a total increase which the eight wheels of the car have to carry, of 107,600 pounds or 240 per cent or 3.3 times as much load.

The wheel used under a 24,000 pound capacity car weighed 525 pounds and the wheel used now under a 100,000 pound capacity car weighs 700 pounds, an increase of 175 pounds or 33 per cent. The brake pressure applied to the eight wheels of a car was formerly 12,600 pounds and at the present time is 30,000 pounds, an increase of 138 per cent. In addition to these changes there have been other changes that have had a material effect upon the service, viz., greater rigidity of car trucks and car bodies, higher speeds, a general introduction of the air brake involving a much greater and more general absorption of energy at the periphery of the car wheel. It thus appears that the work generally imposed upon the wheel in service at the present time is very much more severe than formerly and in this there seems to be little opportunity for disagreement.

I might here state that during this period between the general use of the 24,000 pound capacity car and the introduction of the 100,000 pound capacity car, the requirements of the cast iron wheel imposed by railroads upon manufacturers have been made considerably more severe and comprehensive. The time guarantee has been raised from two to four and five, and in some cases, six years. Physical tests of car wheels have been generally imposed and the thermal test has been added to the drop test. The increased exactions of the railroads in this way have been met by the manufacturers at an actual reduction in price of about 25 per cent.

It has been suggested of late that the cast iron car wheel is no longer equal to the conditions imposed by modern service, unless a very material improvement in quality can be obtained, which no one has thus far been willing to suggest as probable, but it does not follow by any means that such a thing is not possible. While the question of improving the quality to meet these new conditions is under consideration, it occurs to me, that possibly other developments might be brought about which would greatly mitigate the difficulties that are being experienced.

The development of the steel car wheel has been taken up actively by several concerns in this country with the idea of providing something to meet the needs of modern service and there are others who are about to embark in this line of work. They have received a good deal of encouragement and there are those who believe that the real remedy for the present difficulties lies in the use of steel instead of cast iron.. Steel has many qualities that commend it for the purpose, but I do not think it is going too far to state that the use of steel should not be expected to completely eliminate the present troubles, and that whether or not the steel wheel shall be considered essential and come into more general use, it would appear

that it, as well as the cast iron wheel, should be protected, as far as possible, from some of the very trying conditions to which all wheels are now subjected.

The particular failure of wheels that is attracting most attention at the present time is that of the breaking off of the flange. This is not so frequent as might be supposed, but its consequences are often most disastrous and many more wheels are removed before this failure takes place, which might easily so result, than those finally failing in service. In addition to this I find that of all wheels removed from service, not less than 50 per cent are removed on account of worn flanges and in this percentage of those removed on account of worn flanges I include those that are worn away from the flange, usually found on the opposite end of the axle and which cannot be remated. Fifty per cent is the minimum percentage and the maximum that I have found is 85 per cent. My data for this statement is obtained from four heavy service eastern railroads and two typical western railroads.

Taking up first the question of broken flanges I would state that my conclusions are based on personal observation of a large number of wheels examined on several railroads. Comparatively few broken flanges come from the flange being worn thin and broken off laterally through the smallest section at the base of the flange. By far the larger number come as a result of the development of a seam opened on the "*tread*" of the wheel and oftentimes beneath the surface close to the base of the flange, and often before the flange is worn to any considerable extent. Sometimes this seam exists and is not apparent at the surface, in fact I have seen cases where the seam has existed beneath the surface for some time before reaching it, but in the majority of cases the seam extends to the surface at about the same time. In most of the cases examined it has been noted that the fractured metal has a blue discoloration, an indication of oxydization from heat. In thus stating the facts I am confirmed by experienced railway and mechanical men and wheel makers. Several explanations for this failure have been made to the writer but the most logical explanation seems to be as follows:

Figure 1 illustrates the relation between a wheel with a 25 to 1 taper on the tread and the rail head. This shows the wheel and the rail in their normal relation; that is to say, the wheel occupying its proper gauging position with reference to the rail, and it will be seen from this that the contact between the two is reduced to a very small area, in fact, theoretically it is a point. If the wheel occupies a position such that the flange or the throat of the flange is against the rail, the contact will be changed as shown by Figure 2, so that the contact will be practically on the tread at the base of the flange. Frequently heavy loads are carried for some time on the wheels in this way so that under this condition there is an extreme concentration of the load at this point, which is, as a rule, the point at which

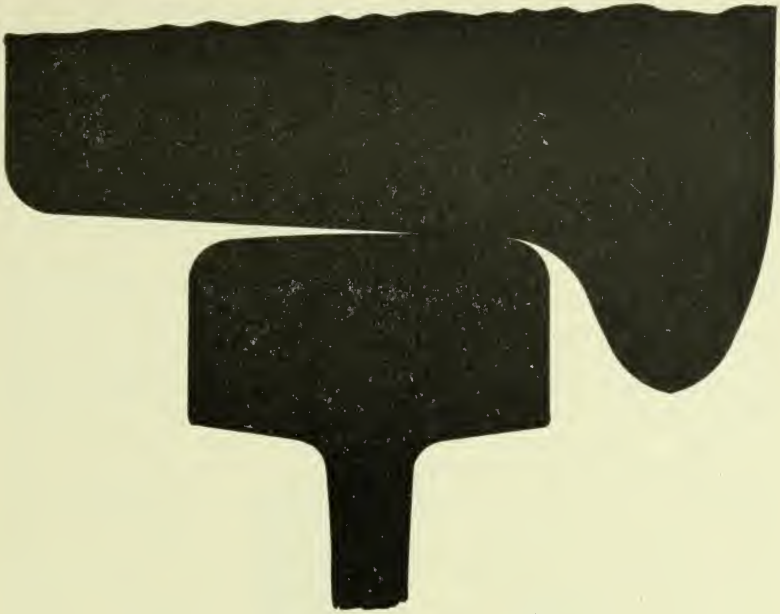


FIG. I.

these seams are developed. At the same time severe application of the brake occurs, the brake shoe bearing heavily on the tread at the base of the flange. Such a combination of conditions as this might occur on a down grade and in passing around a curve. In addition to the heat developed by the brake shoe there is a material increment of heat developed as a result of the abrasion between the flange of the wheel or the base of the flange and the rail. Here, then, is a combination of extreme conditions; in other words, concentrated load and concentrated heat together with considerable lateral pressure against the flange if the car happens to be passing around a curve at considerable speed.

During the period of the lighter capacity car these same conditions prevailed and occasionally the flange of the wheel failed in the same way as they fail at the present time, but such cases were so infrequent and so much less disastrous in their effect than at the present time that little notice was taken of them, so that this apparent development of the broken flange of recent years to a point that has attracted so much attention is not new. It sometimes occurs today under 60,000 pound capacity cars.

In considering greater frequency of flange failures at the present time it must be borne in mind that the number of freight equipment cars in service has increased very greatly during the last few years and the average mileage that these cars make is very much greater

than it used to be, as nearly as I can ascertain about 100 per cent, and the application of air brakes to freight equipment cars is now universal, so, that the increased number of flange failures is readily accounted for, allowing the causes to be practically the same as formerly.

As to the manner in detail by which this seam is developed, I suggest the following explanation:

The sudden application of heat to the tread of the wheel at the base of the flange has the effect primarily of making the metal at the surface expand quickly. The metal below the surface cannot expand so quickly and resists the expansion of the surface metal. The surface metal is therefore put under compression while below the surface the metal is put under tension. The one is working against the other with the result that the metal will yield at the weakest section which would be that part that is under tension. Subsequently, if the conditions prevail for a sufficient length of time the surface will crack also and a thrust against the flange as in passing around a curve would remove a portion if not the entire flange. The operation of heat in this way may be illustrated in large metal ingots. It is not infrequently the case that when a large body of hot steel is poured into an ingot mold, that that part of the metal which comes in contact with the metal mold cools rapidly while that removed from the surface cools very much more gradually, with the result that, as the surface metal tends to contract and is resisted by the body of metal within, the surface metal which is subjected to a

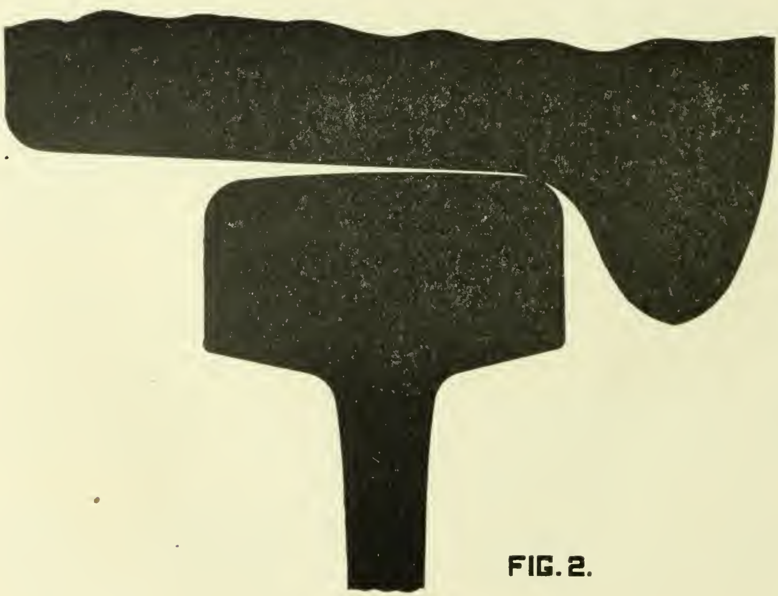


FIG. 2.

pull or tensile stress, yields, and a crack or check develops.

This operation is the reverse of that which takes place in the wheel, but the forces at work are identical and operate in the same way. Add to these conditions brought about by the application of heat, the concentration of load at the same locality with lateral thrust against the flange, and it would seem strange if failures did not occasionally occur.

The writer has seen flanges of steel tired wheels that have failed in the same way as cast iron, but it is a question whether the causes were precisely the same, although it would appear the same causes were largely contributory. Where the load is concentrated as here described it would seem that a piening action must take place to some extent, probably more with the steel than with the cast iron, inasmuch as steel has the quality of ductility and there is at times what is generally designated as a flow of metal under pressure. This piening action would necessarily seem to have a considerable

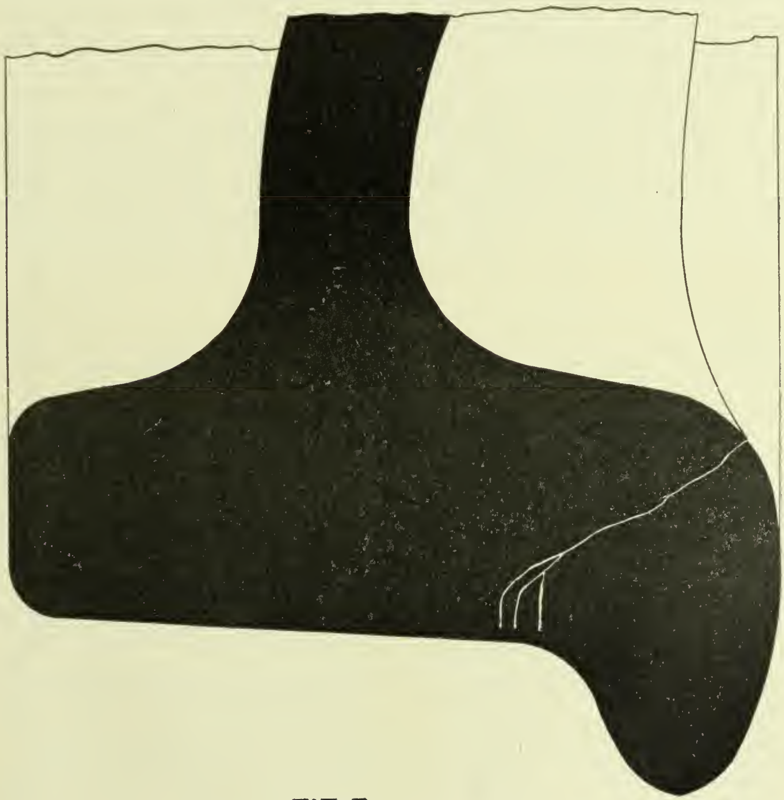


FIG. 3.

influence in the case of the steel wheel, but the chill of the cast iron wheel being so hard, the metal cannot flow as in the case of the steel, but may wear or disintegrate very rapidly if the pressure is extreme. But this piening action, in case of the steel wheel, and the concentration of heat together with considerable and constant lateral pressures, do not appear as unreasonable causes for the failure of the flanges of some steel wheels. It should be borne in mind that on a straight track a wheel is often running to one side constantly and lateral flange pressure is produced.

I might here call attention to the fact that the chills in which cast iron car wheels are cast develop such cracks in the surface in time, as a result of sudden heating and cooling. In fact it is one of the chief reasons for the discarding of chills and the requiring of renewals. It is not at all an unusual thing for heavy castings to crack in a foundry as a result of internal stresses caused by a difference in temperature between the surface of the casting and the metal within. In fact the process of annealing is for the purpose of preventing internal stresses which might cause failure in use, and the practice of soaking wheels or slowly cooling them is provided for the purpose of eliminating internal stresses.

I present here some samples of broken flanges which are typical of the failures that I have described. I desire to lay particular stress on the fact that that part of the fracture which exists at the base of the flange extends vertically for a considerable distance into the tread as shown in Figures 3 and 3A. If the flange itself was not

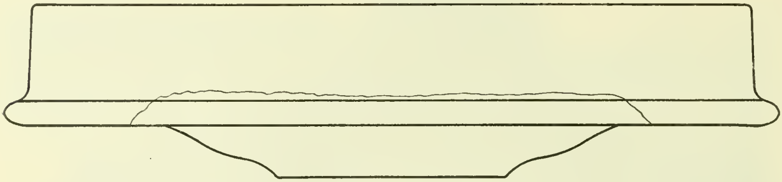
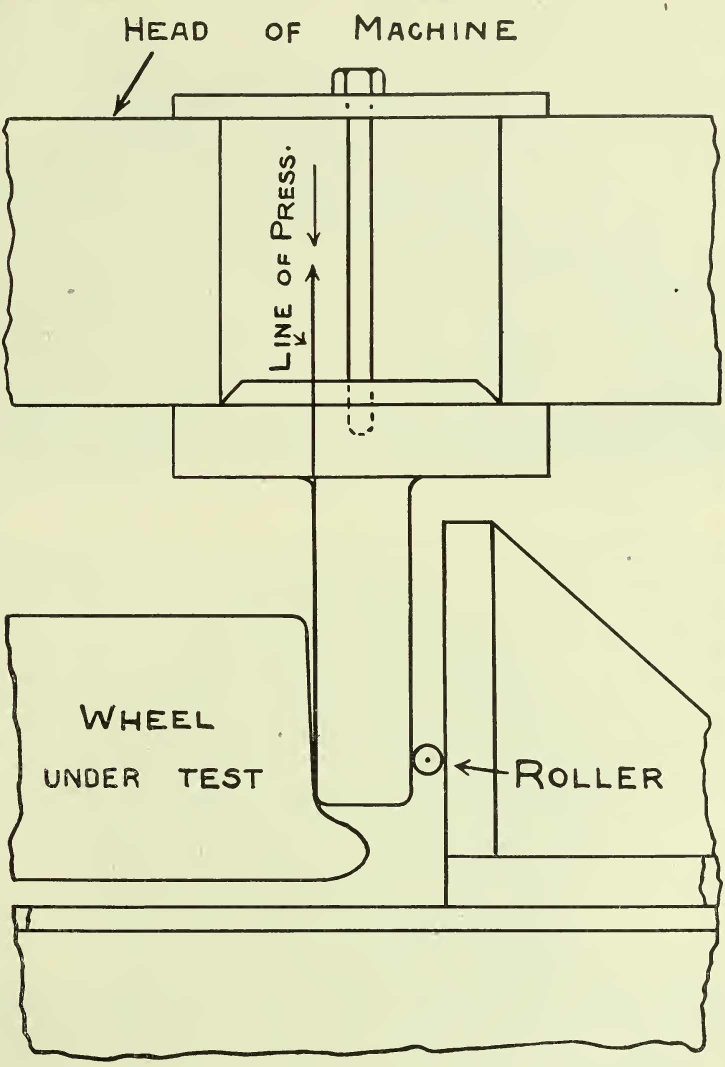


FIG.3.A.

sufficiently strong to successfully resist the lateral thrust it would seem that the fracture, instead of going vertically down into the tread, would go transversely across the base of the flange. There are comparatively few cases that have come to my notice where the fracture has been transversely across the base of the flange. In nearly all such cases that I have examined the flanges have been worn thin vertically and the wheel should not be held responsible.

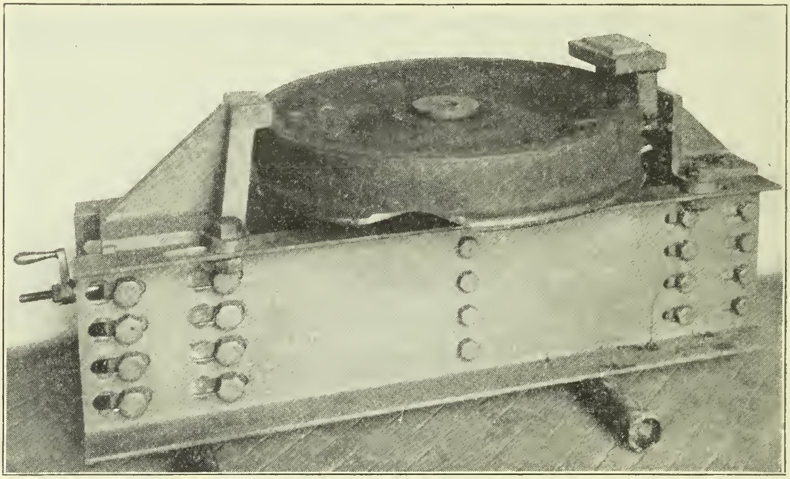
One prominent car builder with whom I have talked in connection with this matter expressed a belief that at points where these seams

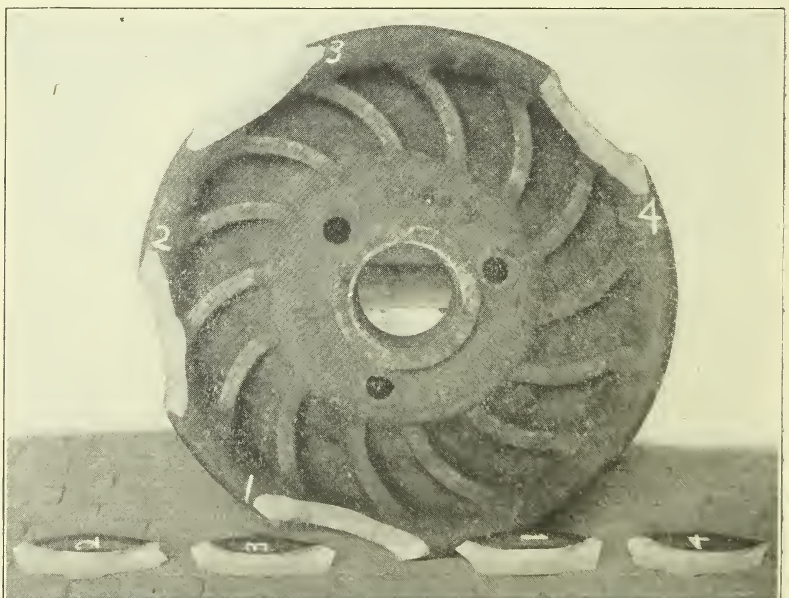
develop there is already an internal stress which might be considered a seam in embryo, and one manufacturer of cast iron wheels



METHOD OF BREAKING FLANGES

suggests that this might occasionally occur, depending upon the conditions of manufacture and particularly depending upon the rapidity of pouring and the temperature of the metal.





The superintendent of motive power of a very prominent railroad that removes from service a large number of seamy wheels states as follows:

"The most serious cause for flange failure is the development of seams at the throat of flange and subsequent breakage. We consider that these seams are the result of concentrated load and heat in combination with poor quality of wheels.

"We believe that the discontinuance of the use of the proper proportion of charcoal pig iron, together with the inauguration of the thermal test and the more liberal use of ferromanganese in connection with the inferior wheel mixture has had more to do with the development of seams at the throat of flanges and the breakage of the latter than any other items."

As has been said, the fracture in the case of flange failures starts in a vertical rather than a horizontal direction as shown in Fig. 3. The thickening of the flange in a horizontal direction will not therefore materially assist in the elimination of this trouble.

In considering this matter I think it is generally felt that the flange of the cast iron wheel is weak, possibly too weak to perform the service required, but in the light of my investigation I cannot see that such a conclusion is fairly reached.

This particular question was of sufficient importance to one railroad to enlist the interest of Purdue University in making some tests for it with a view of determining the pressure required to remove a piece of flange as if it were in contact with the rail. Tests were made under the direction of Prof. L. V. Ludy of Purdue University and conducted as follows:

The wheels were mounted on a suitable support under a heavy service press and the ram of the press was brought down on the flange until the latter gave way. This is shown in detail by the illustration. Three of the wheels tested were taken from service under 100,000 pound capacity cars after having been in service about eight months. A number of others which were tested had not been in service. In all 23 tests were made, the results of which are shown by the following tabulation:

TABLE II.

RESULTS OF FLANGE TESTS.

Number of Test.	Breaking Load	Number of Wheel.	Point of Application of load on flange.	Remarks.
1	52,850	H. 19,413	Between brackets.......	
2	47,750	"	Opposite bracket..	
3	49,350	"	Between brackets.......	
4	53,400	"	Opposite bracket..	
4-a	105,000	"	Load applied on rim....	No fracture.
5	62,850	H. 19,410	Between brackets......	
6	48,700	"	Opposite bracket........	
7	58,250	"	Between brackets.......	
8	58,000	"	Opposite bracket........	
9	74,850	H. 19,254	Between brackets....	
10	72,200	"	Opposite bracket........	
11	87,000	"	Between brackets.......	
12	68,550	"	Opposite bracket.......	
13	99,300	A.C. & F. Co. Wheel 650.	Between brackets.....	
14	100,000	"	Opposite bracket........	
15	105,900	"	Between brackets......	
16	68,200	"	Opposite bracket........	
17	79,350	"	Opposite bracket........	Wheel broke through rim.
18	52,300	H. 19,558	Between brackets.......	Broken wheel. One-half submitted for test.
19	111,600	1904 M.C.B. pattern (Tape 1) 700	Opposite bracket.......	
20	87,000	"	Between brackets.......	
21	109,900	"	Opposite bracket.......	
22	98,900	A.C. & F. Co. Wheel (Tape 2) 700	Opposite bracket.......	
23	98,900	"	Between brackets.......	

From this it will be seen that the minimum load was 47,700 pounds, maximum 111,600, the average about 60,000 pounds. In the case of wheels that have been in service for some time it is probable that the average would be less than this.

The strength of the flange of the steel wheel made by the Schoen Steel Wheel Co., tested at Purdue University with the same apparatus, showed that a pressure of 526,612 pounds was necessary to remove a piece of the flange. This would indicate that the strength of the steel flange was over eight times that of the cast iron, but as I had stated the flanges of steel wheels sometimes fail, also indicating that lateral thrust is not likely to be the primary cause of such a failure, although it may be the ultimate cause.

Mr. Geo. L. Fowler has recently edited, for the Schoen Steel

Wheel Co., a very interesting publication on the subject of the steel wheel and makes comparisons with the cast iron wheel. His arguments are based on the belief that the failure of flanges is primarily and ultimately due to pressure alone, but in this I cannot agree with him. The evidence that I have collected thus far indicates that the number of cases of flanges broken as a result, primarily, of lateral thrust is almost negligible, and that the other causes already described are more likely to be the real ones. He points out, however, and very truly, that the lateral thrust between the flange of the wheel and the rail is oftentimes very considerable, and he has taken great pains to determine accurately just what the lateral thrust is. He has made an exhaustive series of experiments on the Penna. Lines west of Pittsburgh with an apparatus designed by himself, for carefully measuring the lateral thrust in the case of moving cars or trains passing around curves. His measurements were taken at the outer rail near the end of a 4° 25′ curve or a radius of 1,307 feet, the elevation of the outer rail being 3⅞″, which, as he states is correct for a speed of 36.66 miles per hour. Most of his results are obtained from a single car allowed to run alone around these curves at different speeds. At a maximum speed of 30.60 miles per hour, his maximum pressure recorded 12,865 pounds. No doubt the lateral thrusts considerably exceed these figures at times, in fact there can be no doubt about it. I am fully convinced that they do, and have seen evidence within the past thirty days to indicate that such is the case. I have seen a number of arch bars, 1⅛x5″ material, used under 100,000 pound capacity car trucks bent laterally ⅜″, not as a result of wreck or derailment but extreme service conditions. I was told at the time I was shown these bars that similar cases are found from time to time. The cars under which these trucks were used were of very rigid construction, both body and truck, and such evidence as this, together with the information presented by Mr. Fowler from actual measurements, should, I think, confirm anyone in the belief that in the designing of modern cars this item has been greatly neglected.

When the new M. C. B. axles were designed a very important item of allowance was made on account of lateral thrust which reached the axle through the wheel, yet on many railroads at least the thought of relieving the wheel has been given little or no consideration. Some railroads have taken this into account and provide in their truck construction for lateral motion or yielding resistance. The old swing motion truck provided this, and it would seem that some provision for yielding resistance would be highly desirable. Here, I think it is fair to state, that some provision of this kind should not be considered as a complete remedy but as a means for alleviating the difficulty somewhat; in fact, it would seem that a satisfactory provision of this kind would be very material in its effect.

In conclusion on this point I would state that it would seem that if the flanges of cast iron wheels were not sufficiently strong to stand the thrusts of modern service we would have very many more failures than we do; in fact, to my mind we could not have gone as far as we have in the use of the cast iron wheel.

The thickness of the flange has been increased, the limit of wear for the flange has been decreased with the idea that more strength might originally be had and subsequently maintained. Greater coning of the wheel has been recommended and adopted by some, for the purpose of keeping the flange of the wheel away from the rail as much as possible.

With reference to the increased coning the consensus of opinion seems to be that it has rendered some assistance in the matter of making the wheels under trucks in service track better or maintain a proper alignment on straight or tangent track. I call attention to the fact, by referring to Figure 1, that the increased coning has also served to concentrate the load on a smaller area and that too, closer to the flange of the wheel. It would appear that little consideration has been given the matter of dissipating or distributing the load rather than concentrating it, and similarly little attention seems to have been given the matter of the application of brake shoes to the wheels in the way of preventing the concentration of heat at the throat of the flange. When new brake shoes are applied to new wheels it is almost generally the case that the bearing is at the throat alone and in the case of worn wheels at the throat and the outer portion of the tread. It is often the case also that brakes are so hung that the brake shoes themselves wear into the flange at the throat. I have examined a great many cases of late and find this statement to be entirely correct. When a new wheel is put in service on a new rail or even on old rails, the bearing between the two would be as indicated in Figures 1 and 2. As wear takes place which must be very rapid in so small a bearing, the area of contact increases until finally the coning is all worn off except a small portion near the flange, but the tread of the wheel in time increases its bearing so that 1½ or 2", sometimes more, of the width of the tread will be found in contact with the rail. Apparently this is a condition to which it is desired the wheel should come, and it may be said that if wheels are successful in reaching this condition they are likely to continue in successful service giving a normal life unless for some reason there is an extreme condition brought about at some time whereby the heat is concentrated as indicated heretofore. It would appear then, that that portion of the coning which remains may be at times reasonably effective in preventing the wheel from running to the rail. I think it is clearly understood at this time that it is difficult, if not impossible, to mount a large number of wheels on axles and to have each two wheels mounted on the same axle of exactly the same diameter, and the coning, therefore, has for its principal object

the equalization of the differences in diameter. The wheel of smaller diameter will have a tendency to run to the flange and the wheel of larger diameter will have a tendency to run away from the flange. In time they seek a level if not prevented from so doing by other causes which will be spoken of later, and accomplish the result desired. I wish here to draw attention to the fact that with such a limited bearing between the wheel and the rail as is shown by Figure 2, the larger diameter on which the wheel rolls could not be expected to last very long; in fact, it would naturally break down very rapidly and therefore the purpose of the increased diameter might be defeated, particularly if the influence of the greater diameter to turning the truck is not at least equal to the resistance. As a matter of fact the resistance to turning is probably very much greater than this influence, in many cases, and, therefore, a wheel may run constantly for a limited period on this larger diameter without accomplishing the purpose for which the coning is intended.

In my judgment it would seem that having reached this working basis by wear, the coned wheels are in far better condition to withstand service successfully than they were when first put into service for the reason that gradually the load is changed from a concentrated condition on a small area of tread near the flange to a very much larger area extending outwardly toward the edge of the tread.

So far as I have been able to ascertain from railway mechanical

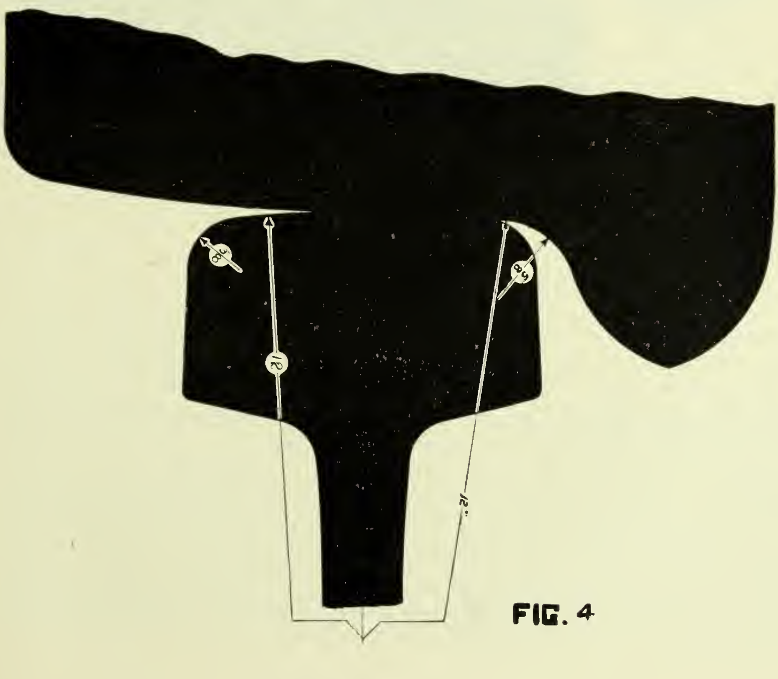


FIG. 4

men this statement of what I have described as a good working basis is regarded by them as correct; at any rate I regard it as correct. If this working basis that I have described is a desirable one to reach, why should it not be brought into play when wheels are first put into service by making the contour accordingly? From an examination of the treads of a large number of wheels I have obtained a composite contour which corresponds very closely to that shown in Figures 4, 5, 6 and 7, and it will be seen that this contour bears quite a different relation to the rail from that shown by Figures 1 and 2. In the former case the bearing is of considerably greater extent, going as a rule beyond the crown of the rail from the flange and instead of the existence of straight coning as is originally applied there is the equivalent extending a short distance from the base of the flange outward and having a radius from 1½″ to 2″

FIG. 5.

before meeting the fillet at the base of the flange which is usually worn to ½″ or less.

It is my contention that a contour of this kind bears a much better relation to the rail, is quite as effective in equalizing the differences in diameter, has the material advantage of dissipating the load on the rail and wheel tread and makes the wheel more serviceable with less opportunity for failure than would the straight coning of 1 in 20 or 1 in 25 recently recommended and now constituting the practice of the country.

It would appear that a coning beyond the fillet, having some relation to the top edge of the rail so as to avoid extreme concentration of load but which would permit the wheel to roll for a short time on a larger diameter, would be a more effective means of protecting the flange than that at present provided.

In conclusion on this point I do not state that this alone would be a cure for existing difficulties, but I do state that it seems reasonable to me, at least, that it will tend to mitigate the difficulties somewhat if I am right in my premises that it is desirable to dissipate loads on the tread of the wheel rather than concentrate them.

FIG. 6.

With reference to the matter of improving the quality of the wheel it would seem that after consideration of the conditions under which wheels operate at the present time as compared with formerly, that there must have been a considerable improvement in the process of manufacture and in the quality, but it is possible that the larger use of ferro-manganese and the introduction of the thermal tests have contributed to the development of seams in cast iron wheels. The thermal test was introduced several years ago, before the high capacity cars were in general use, to prevent wheels from flying to pieces under severe application of the brake, and in this it seems to have been reasonably successful. If, however, as stated by some, a more general use of ferro-manganese has contributed to our present trouble, no doubt in time this difficulty can be overcome and a

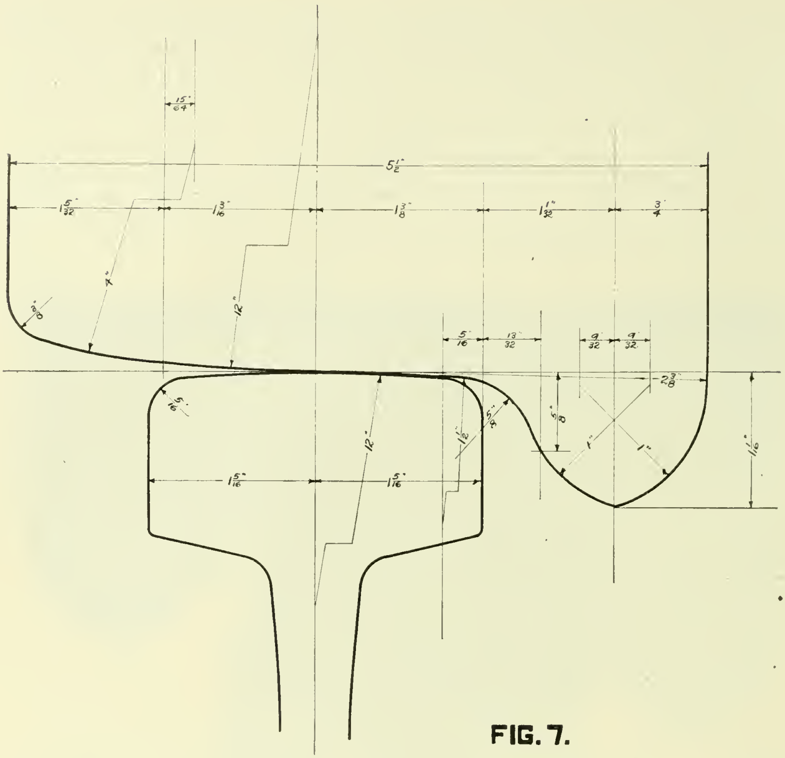


FIG. 7.

more efficient test of wheels might be devised than the thermal test. On this point it would seem that the manufacturers of cast iron wheels might present something that would be helpful.

I have already set forth the greatly increased work required of wheels at the present time. I am of the opinion, generally speaking, that unless an improvement is effected in the quality of wheels the failures will be very much more numerous than they are at the present time. If physical tests are of any practical value in determining quality there can be no doubt but that the quality is better, although it may be entirely possible that a change in chemical composition, such, for instance, as the increased percentage of ferro-manganese used, may have had some effect on the chill whereby it is not so well able to withstand the application of heat.

It is a fact in making slight variations in the chemical makeup of irons and steels that certain relations are oftentimes very radically changed. I can only say that in making my investigations in this direction so little seems to be actually known and so much seems to be unknown that this matter must be approached most conservatively. I am prepared to state beyond a question, as a result of

actual experience in making wheels, that it is entirely possible to produce a cast iron wheel the body of which will be very much tougher and stronger than is the case today.

A short time since, wishing to ascertain something about this matter, I made a number of wheels with the idea of eliminating some of the elements that usually make cast iron what it is, viz.: brittle. By greatly reducing the phosphorus and sulphur content I succeeded in making a wheel, the flange and body of which were incomparably stronger than anything that has been commercially produced up to the present time, but I am not at all prepared to state whether the chill of such wheels, if subjected to the conditions of concentrated load and heat at the present time, would withstand existing conditions any better than do the average wheels, although it appears quite probable. It is well known that sulphur is an element that makes for brittleness yet it also makes for hardness. It is well known that phosphorus makes for brittleness and greatly reduces strength, but it is possible that with a reduction of sulphur and phosphorus content some other element might be substituted which might greatly improve the quality of the chill. There has, however, been little done in the way of investigation along these lines, and I am led to believe that wheel manufacturers have had little inducement to pursue investigations of this kind. I might here state that if an improvement in the quality of the wheels is desired it is absolutely certain that an increase in the cost will be unavoidable. I hope to be able to pursue this phase of the question later, but at the present time it is my desire to point out other possible remedies which may materially alleviate the difficulty of broken and worn flanges, not only in the case of the cast iron wheel but of the steel wheel as well.

While the matter of improving the quality of the wheel must necessarily be a very gradual one and worked out by experiment, covering, no doubt, a considerable period of time, the question arises in the meantime what other things suggest themselves as partial remedies. I have already pointed out that the concentration of heat is one of the probable causes of failure at the presnt time and it has occurred to me that probably something might be done to avoid this. Would it not be possible to so design our brake shoes so as to prevent any material bearing or development of friction and heat either at the flange or on the tread of the wheel near the flange where the load is often concentrated? In discussing this matter with one railroad man a short time since he suggested that he thought the area of brake shoe contact with the wheel was already rather limited and that if contracted any further it would be a disadvantage rather than an advantage. Since that time I have taken occasion to inspect a large number of brake shoes in service and find that probably not more than one-half of those in service have effective use of more than 50 per cent of their full area. The width of the present brake

shoe is not equal to the width of the wheel tread and therefore in cutting away some of the brake shoe surface at one point it might be added at the outer edge of the wheel and possibly it might be made to cover the flange. This might necessitate some modification of the brake shoe holder and of the point of bearing of the brake beam, but I am led to the belief that a great deal can be done by changing the shape of the brake shoe alone, that is, by cutting away the bearing near the flange. I wish to point out again that I do not present this as an absolute cure for the difficulties that exist, but as something that would tend in the direction of mitigating the difficulties. In fact I believe that the means suggested for diffusing the load and preventing the concentration of heat would have a decided influence towards reducing wheel failures.

From one railway where the service is exceedingly heavy I have obtained the following facts concerning the removal of wheels during the year 1907:

Total wheels removed for all causes, 79,000.

Wheels removed on account of seams at or near throat on thread, without failure of flange, 3,312.

I might here say that this condition is typical of the conditions on a number of other roads with which I am familiar and which I have investigated, and it seems to lend considerable weight to the argument that I have here advanced concerning the concentration of heat and load.

I have already made the statement that of all wheels removed from the service on two typical western roads and four heavy service eastern roads, about 50 per cent are removed on account of worn flanges with a maximum of 86 per cent on one road. The enormous loss of wheel service on this account, to say nothing of the necessity of holding cars out of service for the purpose of renewing wheels and of increased train resistance seem to be, at least, a waste and expense that should be avoided somewhat, if possible. Whether the quality of the cast iron wheel is improved or whether the steel wheel is brought into more general use, this item of worn flanges will continue and be more expensive with the increased first cost of wheels. Considerable has already been said by others concerning this matter and also about means for preventing it. A few railroads have taken some active steps towards minimizing this waste, but the majority seem to have done little. The difficulty seems to lie in the fact that wheels under cars do not track as intended; that is to say, the alignment of the wheels is not coincident with the alignment of the rails.

It is well understood that this flange wear is not produced as a result of passing around curves; it takes place on straight or tangent track; it is so general and has extended for so long a time that it seems fair to state that the wheels are not permitted to track. I say this for the reason that in some cases where they are permitted

to track they do track. It is often the case, as stated previously, that wheels mounted on the same axle are not of exactly the same diameter and it is the tendency for a wheel of smaller diameter to wear toward the flange. The coning is intended to overcome this difficulty. In some cases it seems to be effective and in other cases to the extent already noted it does not seem to be effective. There is considerable evidence to show that coning might be made more effective if the resistance of the trucks to pivoting or turning about their pivotal center could be materially reduced.

It has been well established that the resistance of trains has considerably diminished in the case of cars where the body and truck side bearings are free or clear of each other, and where the resistance to pivoting is principally at the center bearing. Numerous papers have been presented and numerous discussions have taken place before this club covering this point and I think it is safe to say that this principle is so well established that it is regarded as right and necessary to construct cars that shall have the side bearings free and continue so for some time at least. I would call attention, however, to the fact that on some roads, if not on most, where this effort has been made with considerable success to keep side bearings clear that the percentage of wheels removed on account of worn flanges has, instead of decreasing, actually increased; in fact, on one heavy service railroad in comparing the service of wheels under 40,000 and 60,000 pound capacity cars, with those under 100,000 pound capacity cars, I find that the average life of the wheels has been reduced until now it is but 33 per cent under high capacity cars of that which it was formerly under the lighter capacity cars, and that 75 per cent of all the wheels removed are on account of worn flanges, which, as I have said, includes those that are worn away from the flange and cannot be remated but which are not worn through the chill. This would seem to indicate that this condition, while possibly reaching the extreme on this particular railroad, exists to a marked extent on all railroads or nearly so, and that enough has not yet been done to provide an efficient or partially efficient remedy.

Some years ago, one railroad in this country having its interest aroused, determined to pursue this matter with a view of ascertaining what might be done and I believe that many of the members of this club here present will recall the paper and discussion, the basis of which was furnished by the Pittsburgh & Lake Erie R. R. Mr. L. H. Turner, S. M. P., has kindly furnished me with a resume of his experiments in this direction.

After making preliminary tests about seven years ago and reaching the conclusion that an anti-friction center bearing would relieve the worn flanges, they commenced to equip some of their cars with the ball bearing center and side bearings so that at the present time they have a total of 8,600 cars so equipped and 6,961 cars without.

The latter are older cars of ordinary design, largely coal cars or gondolas. The average life of the ball bearing cars at the present time is between three and four years, quite long enough it would appear, to ascertain whether the tendency of the ball bearings has operated in the direction of avoiding worn flanges. Covering a period of thirty-six months, ending May 31st, 1907, I find that 19,608 or 86 per cent of all the wheels removed, both from their own and foreign cars were removed on account of worn flanges; that 472 or 2 1/10 per cent were removed from ball bearings; that 8,926 or 39.2 per cent were removed from the non-ball bearing cars of their own equipment and 10,207 or 44.8 per cent were removed from foreign cars, out of a total of 22,806 wheels removed from all causes.

It is true that these figures may not accurately and comprehensively state the entire situation, but it would seem to be reasonably clear that with 8,600 cars in service an average of over three years, that only 2 1/10 per cent of the wheels removed in that time were due to worn flanges, is considerable and important evidence to the effect that if wheels have a better opportunity to track they will do so.

It may be true that the particular device which the P. & L. E. R. R. used has not been all that might be desired. It is true that balls have broken and that they have become imbedded in the plates, and there is considerable that may be desired before pronouncing this anti-friction center bearing entirely satisfactory, but there is no gainsaying the fact that if the accomplishment in saving wheels were one-half that which he states, the results should be well worthy of serious consideration.

Some shop tests made recently by one railroad with a view of determining the difference in resistance between anti-friction center bearings and plain center bearings show that the resistance to turning of a dry cast steel or malleable iron center bearing as compared with the anti-friction center bearing is as six to one and in one case over fifty to one. Mr. Turner, in his shop tests, gives the relation as about three and one-half to one, but there is reason to believe that in service this relation might be somewhat changed and not be quite so great. In case of the bearing used by the P. & L. E. the construction is such that in passing around a curve the action of the balls on their seats raises the body of the car slightly and when passing off the curve on to a tangent this elevation of the car body is applied to return the truck to its normal and proper position, with relation to the rail. Other anti-friction center bearings thus far developed do not appear to have included this feature and it is not evident at this time to what extent this is an advantage, for with an efficient anti-friction center bearing without this feature the wheels themselves would be expected to return the truck to the same normal position.

I feel that the P. & L. E. R. R. is entitled to a great deal of credit

in carrying this work as far as it has, and am convinced that in these results which Mr. Turner has presented there must be enough reliable substance to warrant the belief that many railway men have had, that something of the kind would be valuable for the purpose intended. What I desire to point out in this connection is that one railroad has tried and obtained results and that if attention and effort are concentrated on this subject by other railroads or by railroads in general, that an entirely efficient means will be developed for relieving the car wheel from what appears to be an unnecessary burden. It is usually the case that where there is concentration of effort, results are forthcoming.

The inability of wheels to track, it would seem, has some bearing on the failure of flanges in that a wheel would be crowded constantly toward the flange and would necessarily have its load concentrated near the flange. In this way I am of the opinion that some additional relief might be given the already over-burdened wheel.

Finally, to summarize the points that I have endeavored to make and laying aside, for the present, the matter of improving the quality of the wheel, which is a work that must necessarily go on, I would suggest first, avoid the concentration of load by the use of a more satisfactory relation between the contour of the wheel and that of the rail; second, avoid the concentration of heat at or near the flange of the wheel by a modification of the brake practice; third, relieve the oftentimes existing high pressures against the flange by introducing the feature of lateral motion in truck construction, so that a considerable yielding resistance will be offered instead of an abrupt one; fourth, for the purpose of avoiding the excessive wear of wheel flanges of all kinds, modify the contour and provide means whereby the resistance to the pivoting of the truck and of the wheels to track may be very materially reduced.

(Applause.)

The President: Before opening this paper for discussion I wish to advise that we have a communication from the Chairman of the Master Car Builders' Association Committee on Cast Iron Wheels, that is very pertinent and will be read by the Secretary.

The Secretary: Mr. President, this letter is from Mr. Wm. Garstang, Supt. M. P., C. C. C. & St. L. Ry. Mr. Garstang is not only Chairman of the Committee of the Master Car Builders' Association on Cast Iron Wheels, but is a member of the Committee of the American Railway Association on Standard Wheel and Rail Sections. The letter is as follows:

Indianapolis, Ind., Jan. 20, 1908.

Mr. Joseph W. Taylor, Sec'y, Western Railway Club, Chicago, Ill.

Dear Sir: Having read the advance copy of Mr. Bush's paper on "The Car Wheel and its Relation to the Rail and Car" with a great deal of interest. it seems to me that supplemental information following the same lines on this

important subject, which has been in the possession of the members of the M. C. B. Wheel Committee for the past several years should be furnished for the benefit of the members and I take pleasure in presenting same in order that the discussion invited by Mr. Bush may develop along lines which will be equally profitable to us all.

In order to concentrate this letter to the salient points of the subject from the standpoint viewed by the M. C. B. Wheel Committee, I shall endeavor to follow the summary of Mr. Bush's paper in the order named, commenting briefly along the line of view above mentioned as follows:

"To avoid the concentration of load by the use of a more satisfactory relation between the contour of the wheel and that of the rail." Taking for example the 100,000 lb. car cited in Mr. Bush's paper, we will have a load on the rail, at each wheel, of 19,000 lbs., the normal position of such wheel in relation to the rail being shown by Mr. Bush as Fig. 1 while in Fig. 2, he shows the same wheel running with throat radius of flange in contact with the top corner radius of the rail, both wheels shown in these cuts having a taper of 1 in. in 25 in., and a throat radius of ⅝ in.

The M. C. B. wheel tread and flange of today has a taper of 1 in. in 20 in. and a throat radius of 11/16 in., both of which therefore would slightly alter the conditions presented by the cuts shown.

Experiments recently made show the actual area of contact, per Fig. 1, between a 33 in. cast iron car wheel and a 100 lb. rail, when the load is 19,000 lbs. is 19/100 or a fraction less than 1/5 of a square inch, and as this area of contact must be due solely to the elasticity in the rail or wheel, or both, at the point of contact, it is difficult to consider that Fig. 2 accurately presents the true relation between wheel and rail under the conditions imposed, since the ratio of pressure per square inch or the elasticity of rail or wheel is in nowise altered.

As Fig. 1 and Fig. 2 are presented in Mr. Bush's paper to show an undesirable relation between coned wheel contours and rail as viewed from one standpoint, also, as Fig. 7, which practically eliminates the coning of the wheel tread, is presented in same paper as a desirable contour of wheel tread to better the relation between wheel and rail, it becomes my duty as Chairman of the M. C. B. Cast-Iron Wheel Committee, also, as a member of the American Railway Association Committee on rail and wheel sections to present the following in support of the action of both of these Committees to date in regard to the necessity for coning the treads as well as the desirability of increasing such coning above practice current prior to 1906.

Coning of wheel tread contours primarily introduced to prevent hunting or lateral sinuous action of a pair of wheels when in motion over a track, not only fulfills its function in this regard but presents an opportunity for any two wheels mounted on a common axle to find their own center, or in other words a diameter common to both, and the value of such coning increased from the original of 1 in. in 32 in. to the 1 in. in 20 in. of the present day, is unquestionably established by reports from various European Railways whose representative Mechanical Officers' opinions on this phase of the subject have been solicited by at least one of the most prominent railways of this country who are large users of wheels and whose investigation in this direction had warranted the trial of wheels having tread contours coned 1 in. in 20 in. and whose experiments were continued with wheels coned as sharply as 1 in. in 13 in. for a comparatively small number of wheels, the results of which are not yet sufficiently defined to bring same into this letter.

For the wheels coned 1 in. in 20 in., the Railway Company in question alone has had upwards of 230,000 wheels of this class in service for the past two years and their total removals of these wheels for all cracked, chipped or broken flanges under 80,000 and 100,000 lb. cars are 3/10 of 1 per cent and the officers of this company are emphatic in their advocacy of such tread

coning to the extent of exclusion of any wheels not conforming to such practice for their use.

The intrinsic value of such coning in relieving flange stresses must certainly lie in the tendency of the wheels to seek a common center in a more pronounced manner than the flatter wheels and conditions represented by Mr. Bush's Fig. 2 become less frequent, and the flange shock more gradual and greatly reduced.

Flange tests, as reported in Table II, page 10, present an interesting phase of the subject as determined from the tests at Purdue University, but in the case of all wheels from tests Nos. 1 to 12 inclusive, it must be borne in mind that they were of the original M. C. B. standard form of 1903, and earlier, and their total values should be calculated alone as a group and not considered in all the wheels covered by the table, when getting the average value of the flange strengths.

Tests numbers 13 to 17 inclusive represent the results from a form of reinforced flange used by one manufacturer, and wheels represented by tests numbers 19 to 23 represent the flange adopted by the M. C. B. Association in 1904, and current practice to 1906, when the strengthened flange of today was presented to and adopted by that Association, and subsequently adopted by the American Railway Association. Therefore, the flange strengths of the 1904 standard wheel, must be determined by the averaging of results of tests 19 to 23 inclusive, which would raise the value from 60,000 lbs. to 101,000 lbs. No figures or tests are extant to determine the value of the strengthened flange of today's standard, but it is confidently assumed, by myself at least, that 10 per cent increase in strength, or 111,000 lbs., will represent the average value.

In regard to the belief expressed in Mr. Bush's paper that it would be advisable to confine the throat radius of the flange to ⅝ in. or less, we would say. a large number of reports were received from various railroads which have been experimenting with wheels having increased throat radii, and some of them have advanced the radius to ¾ in. with marked success, in practical use, and a statement of one member of the M. C. B. Association in Southeastern territory, where sharp curves and heavy grades prevail, and who has, for the last five years, been gradually increasing the throat radius of wheels, will be interesting in this connection, and I quote from letter received from this gentleman as follows:

"Five years ago we commenced a larger radius than the standard at that time called for. This was done for the purpose of reducing the number of sharp flanges in Southern Territory, where sharp flange wheels are a serious cost. Improvement was marked, and the radius was gradually increased until 15/16 in. was used, not only for cast iron wheels, but also for steel tired coach wheels and engine tires.

There has been a vast improvement in the wear of wheels, with no perceptible effect on rail wear, and the chill of the cast iron wheels at the throat has been vastly improved thereby, and I commend this to the attention of your Committee."

The foregoing is only one endorsement among the many now in the records of the work of this Committee, and we feel that Mr. Bush would be one of the minority, if his views on this point are correctly interpreted.

Reference to Fig. 3 on page 6 of Mr. Bush's paper, will show the lines generally, and almost universally taken by the fracture, when the flange of a chilled cast iron wheel fails, and approximately this line, as shown, was used by the M. C. B. Committee in strengthening the flange, and an examination of the cut produced on page 556 of the 1906 M. C. B. Proceedings, will show the relative amount of metal added to the 1904 wheels at this point.

Commenting on the vertical portions of lines of fracture extending into the

tread, we must say the action of a chill on molten cast iron causes such changes in the molecular structure as to produce what might be termed end grain of the metal to the chill and the longitudinal flow of this end grain would be radial or toward the center of the wheel and its depth would be regulated by the penetration of the chill, and any fracture that might result either from over-straining, or from defects of manufacture, would certainly follow a vertical line of cleavage along this end grain, until the depth of the chill was reached, after which it would follow the line of least resistance, or approximately the angle shown by Mr. Bush's Fig. 3.

In 1905 the M. C. B. Cast Iron Wheel Committee was authorized to work in connection with a Committee from the American Railway Association which was investigating the rail and wheel sections, with a view of harmonizing both for the benefit of the service, and we have, therefore, been constantly in touch with the situation as viewed from the standpoint of the American Railway Association Committee which subsequently received and endorsed the strengthened flange adopted by the M. C. B. Association, and in force today. This American Railway Association Committee is now engaged in compiling a report to the American Railway Association, advocating a standard rail section on which the ball of the rail has a 12 in. crown radius terminating in 3/8 in. corner radii, with both sides of the ball inclined three degrees from the vertical, and which, it is proposed, will be especially adapted to work economically with the standard wheel, and thereby minimize failures of either wheels or rail, that have been prominent since the advent of heavy equipment now in use.

All points above are not experiments in any sense, as numerous and prolonged trials have been repeatedly made under the auspices of this joint Committee, in different sections of the country, and in particular support of the action of the M. C. B. Wheel Commitee in April, 1907, on which flange failures of the 1904 standard M. C. B. wheel, having a coning of 1 in. in 25 in. and a throat radii of 11/16 in. are reported, that out of 257,500, (650 lb.) wheels and 230,737 (700 lb.) included, the per cent of flange failures for 650 lb. wheels is 16/100 of 1 per cent and for 700 lb. wheels is 15/100 of 1 per cent and I may further say that out of 58,500 wheels under 80,000 cars reported by one of the Northwestern railroads, and 58,600 wheels under 100,000 cars reported by one of the Southeastern railroads, the per cent of failure in each case is 17/100 of 1 per cent.

It is my desire to impress on the gentlemen who will hear this read, or will read same in the Proceedings of this Club when the latter are ready for distribution, that this subject in connection with the subject of the rail section is one of the most important before the country today and we consider that since it has been intrusted to the hands of a joint Committee under the auspices of the American Railway Association whose investigations cannot fail to include every phase of the subject that their final report will be unquestionable, still, we know that this Committee will welcome the receipt of any suggestions or recommendations that any interested parties may care to present.

Yours truly,

Wm. Garstang.

Mr. C. A. Schroyer (C. & N. W. Ry.): I do not recall any paper that has been presented before this Club for years that bears so much of interest to the railroads as does this paper on cast iron wheels, especially from the standpoint of safety. Now, from what I know of this paper and the trend of the opinions of the different members, I am led to believe that a great many members want to say something on it, and I believe that short and concise discussion on this will result

in very much more good than long drawn out discussions, so that I would move you that in the discussion of this paper we limit the discussions to ten minutes, unless the time may be extended by vote of the house.

The President: You have heard the motion, gentlemen; is there a second?

It has been moved and seconded that the discussion be limited to ten minutes, unless unanimous consent is given. All in favor, signify by saying aye.

Motion carried.

The President: I hold in my hand a blue print which seems very opportune to this discussion; it is a C. M. & St. P. Ry. print made from a tracing August 22, 1900, seven and one half years ago. The incidental interest in this is that it is approved by S. P. Bush, Superintendent of Motive Power, and the contour of this wheel is almost identical with that which Mr. Bush gives in his paper, so that it has a remarkable feature of consistency.

The subject is now open for discussion. Mr. Manchester, will you please open the discussion?

Mr A. E. Manchester (C. M. & St. P. Ry.): Mr. President, the subject of wheels, as expressed by Mr. Schroyer, is about on the same line as coal, consumption or the labor question on a railroad. It is one of the very large items of expense and any suggestions or information that will extend the life of the wheel and increase the safety of the wheel will be a great boon to railroads at this time. However, in the very beginning of the paper it makes the assertion that the duty of the wheel has increased 3.3 times by the increased capacity of the car; that the weight of the wheel has increased 33 per cent, I think it is, and that the price of the wheel has been reduced 25 per cent and that the guaranty of the maker has increased from two to three times. Now, taking these as a whole, and figuring them together, it does not appeal to me as representing a condition that calls for an alarming condition of any wheel today.

There is another feature in the paper that pleases me, and that is, that it is working along the line, or making suggestions that do not call for an entire change of our wheel equipment. The wheels under our 2,000,000 freight cars represent to the owners of the cars something like $150,000,000. If it was a proposition looking toward the replacing of the cast iron wheel with a steel wheel, even though the steel wheel were already in sufficient quantities to be placed on the market, the cost of the steel wheel, from any figures I have ever seen given for a steel wheel, would represent such enormous figures that the largest cost that has been suggested for the completion of the Panama Canal would look like thirty-five cents beside it.

As to whether the cast iron wheel has outlived its usefulness, I

hardly believe that what I have already said and what has been said in the paper bears out this proposition, but I do believe that there are still great possibilities for improvement in the cast iron wheel; that the contour and form of the wheel may be benefited by some of the suggestions as made by either the writer or by the Master Car Builders Committee, and that a better quality of material will give a stronger and more serviceable wheel.

The paper, as has been stated by the President, does very largely suggest a wheel contour along the lines that have been followed by the Chicago, Milwaukee & St. Paul Railroad for the last eight years, and possibly the result of the flange failures in that service is one of the things that leads me to believe that the cast iron wheel is a long ways from having become obsolete or outlived its usefulness.

I agree with the writer of the paper in the position he takes relative to the form that the coned wheel must assume after it has run a short time, that is, that the wheel will track in a way to adjust itself to uniform sizes and that the cone will soon cease to be a factor of guiding the wheel. The C. M. & St. P. Ry. contour simply starts out with that form and condition of the new wheel. The effect of flange wear is not, I believe, eliminated or lessened by the change in contour, but I do believe that flange failures are reduced, whether it be from causes as suggested by the paper, the concentration of the load in a small space, or whether it be from the fact that the wheel as manufactured by the company contains a better grade of material, a certain amount of new charcoal iron being applied to it to keep up the strength of the wheel and the avoiding of ferro-manganese to give the wheel strength, I am not prepared to say. But I do believe that with proper mixtures and proper form of the wheel, that the possibilities of the cast iron wheel are great, that it has not outlived its usefulness and that it is still capable of carrying 100,000 capacity cars when it is properly made.

Mr. M. K. Barnum (C. B. & Q. Ry.): Mr. President, I have some figures here that may be of interest and corroborate those given by the author of the paper. I have the cause of condemnation for cast iron wheels on five different railroads during the last fiscal year, and it seems to furnish an object lesson. The percentage of wheels condemned for worn flanges varied from 12 to 31 per cent, for passenger cars; for locomotives and tenders, it varied from 29 to 41 per cent, and for freight cars from 48 to 62 per cent. The object lesson that occurs to me is that the very great difference in percentage of worn flanges between the passenger cars and freight cars shows the value and necessity of more attention to freight car trucks.

The author of the paper has pointed out some features which should be given more attention and mentions especially the providing of lateral motion, and the reduction of the pivotal friction in the truck. Both of these will inevitably reduce the flange friction and relieve

some of the strains to which all wheels used in rigid trucks with common cast center and side bearings are now subject.

A committee of the Master Car Builders' Association reported in 1902 and 1903 on the matter of center plates and side bearings and gave some very valuable information, but it does not seem to have created a very strong impression, judging from the persistence of the railroads in following the old practice. A study of this subject shows that it is a very simple matter to greatly reduce the pivotal resistance in several ways. In the first place, it is possible to reduce the friction 75 per cent. by lubrication, yet many railroads pay very little attention to lubricating center plates and side bearings. It is possible to do still more by using some of the various anti-friction center plates and side bearings. Some of them are rather experimental yet, but there are several that have shown a great deal of merit and will reduce the pivotal resistance between 85 and 95 per cent. Some of them do even more in a laboratory test, but of course it remains to be seen what damage service shocks will do in the way of breaking the balls or rollers. But to be brief, I do not believe that many railroads have begun to show the interest, or exert themselves as they might, in improving the conditions under which the wheels now have to operate.

Mr. Schroyer: I would like to say something on the subject of wheels, being a user of them. It appears to me we are talking around the outside edge; we do not go right at the thing that is staring us in the face. The thing that is staring us in the face today in the matter of the cast iron wheel, and the thing we are afraid of, is the breakage of the flange under our heavy carrying capacity cars. In my experience in car building, we have increased the carrying capacity of our cars from 30,000 pounds to 100,000 pounds, and we have increased the weight of the wheel from 550 pounds to 650 pounds under our 80,000 pound cars, and 700 pounds under the 100,000 pound cars. The percentage of increase in weight and carrying capacity of the car, you see, has been as much as four fold; the percentage of the increase in the amount of stock that we are putting ino a cast iron wheel is very small as compared to the percentage of increase in the load carried.

The weak point, to my mind, in the cast iron wheel today is the flange and the surface of the tread immediately inside of the flange. The increase in the percentage of sharp flange wheels today in cast iron equipment is not commensurate with the increase in the carrying capacity of the cars, and the increase in the speed of the trains. Our increase in sharp flange wheels removed is low, that is, the increase in the number removed is low as compared with the speed and the load. If we measure up against the wheels that have been removed for sharp flangs alone, it will run approximately 55 per cent, but the wheels that have been removed for this cause have made a greater average mileage in service than the average of all the wheels that

have been removed for all other causes, and greater mileage or time than is received from the makers on the guarantee. There is not anything about such a condition as that to worry us very much, so far as the cost of maintenance is concerned, but the thing we have to worry about is the matter of the breaking of the flanges, due to a hidden defect, caused, as I think, by an internal strain or a combination of this and the continued heating and cooling under brake application and friction produced by the flange wearing against the rail head, both on curves and tangents, it being impossible to discover this hidden defect until the tread and flange is worn to such an extent as to expose them, and very often breakages occur before they can be detected.

I want to call your attention to another thing in this connection, that is, the breakage of these flanges is largely confined to certain makes of wheels and under certain weights of equipment. I know that some of the manufacturers who have had the most failures with the wheels under heavy capacity cars use the very best stock. I know that to be a fact, so that I am inclined to think that it is not the man that is putting in the highest priced stock that is necessarily getting the best wheel. I believe that a wheel may be something like a brake shoe, that you can take any old iron and throw it into the cupola and make the finest kind of a brake shoe. I think it may be possible to put a medium grade of metal in a cupola and produce the best results in wheels. The cause of the crack in the flange or in the tread which develops after a certain length of time in service, and most frequently in our experience it is when the flange has worn to a certain degree of sharpness that these breakages occur, is a hidden defect due, I believe, to an internal strain. It is a fact that these breakages always occur on a curve and when a wheel is worn to a sharp flange and it strikes a curve, it is that worn point of the sharp portion of the flange that strikes the rail head on the curve, that is, the throat of the flange, which is running too sharp, does not strike the rail head at all, so that you can readily observe the increased leverage or strain there would be up in the throat of the flange, when the point of the worn portion of it is striking on the rail head.

We have a number of wheel makers here tonight, and a number of men who are well versed on both steel and cast iron wheels, and I think it would be well for us to hear from them.

In the latter part of this paper the writer refers to the use of a center plate having ball bearings and side bearings having balls or rollers in them. I do not believe that side bearings or ball center plates have anything to do with sharp flanges. I know we have been told that a great many times. I believe the friction side bearing has something to do with rail wear; it has something to do with the coal pile, but it does not have very much to do with the sharp flange on a wheel; if it did, both wheels on the same axle would run to sharp

flange if the bearings were the cause of it. The case that is cited here of so small a percentage of wheels being removed for sharp flanges from these cars and the roller center bearings being in service three years,—if our wheels ran sharp flanges in three years, I would recommend to our management to get some other wheel makers to make our wheels,—would lead us to reasonably expect wheels in service so short a time as that would show a very low percentage of wheels removed from that cause.

Mr. E. S. Woods (E. S. Wood & Co.): Mr. Schroyer's point seems to be that a mismated wheel will cause a sharp flange and perhaps cause more sharp flanges than anything else, and I think that is a true statement. A mismated wheel will run into a sharp flange almost every time. Sometimes the wheels are not mismated when they come into service, but one may be a little softer than the other and will become mismated before they run very long, so that the point Mr. Schroyer raises has foundation to it.

The President: We would like very much to hear from any of the cast iron wheelmakers who are present who desire the privilege of the floor, whether members or not. If Mr. Schroyer can nominate anybody to take the floor, we will be glad to hear from him. I understand Mr. Griffin intended to be present at this meeting and if he is here, we would like to hear from him.

Mr. Schroyer: I was going to suggest Mr. Fowler, because I know he will say something that will put Mr. Griffin on edge, and then you will hear something else.

President: We will hear from Mr. Fowler.

Mr. G. L. Fowler: This is my first appearance at this Club, although of course I have been familiar with the proceedings for many years and familiar with the high character of them, and I think I must compliment you on the paper you have before you tonight as fully maintaining its previous reputation.

It has been my privilege in the last two or three years to be engaged in investigations in regard to certain characteristic features of car wheels and the stresses which are put on them and the requirements they are obliged to meet in order to work succssfully under high capacity cars. I do not think anybody can have a higher opinion of cast iron wheels than I have. When we first began to use them, our cars were mere baby carriages that carried ten tons and weighed as much more and they carried a total weight of perhaps 40,000 pounds, and now we are loading them to from 150,000 to 160,000 pounds, so that the figures given by Mr. Bush in his paper, fully emphasize the tremendous difficulties and conditions under which the cast iron wheel is obliged to act, as compared to what it did twenty-five years ago, and I think that fully explains the trouble which we have with it under high capacity cars. It seems to be working all right under 60,000 and 80,000 pound cars, but when we reached the

100,000 pound cars, that appeared to be the last straw on the camel's back and down it went, and there is a tremendous amount of flange breakage as a consequence. Now, this is nothing against the cast iron wheel any more than a building constructed many years ago falling short of fulfilling, or the failure of an old bridge to meet modern requirements; it is the result of growth, and the thing to do is to tear it down and build one that is suitable to meet the demands of the day, and that is exactly what the railroad is doing in the case of the cast iron wheel, for, on account of its failure under 100,000 pound capacity cars, there is demand for something stronger to do the work.

In regard to the lateral thrust on the wheel, which Mr. Bush refers to, indicating that my opinion was that it was the principal cause of failure, I am sorry that I conveyed any such impression as that. I merely think it is an important, a very mportant factor in the case, but that it is not the only factor just as there may be several causes for the shelling out though none can be said to be the only cause.

In regard to the brake shoe action, the breakage of flanges would almost invariably show that they are broken in detail; that is, you will find a small crack started in the interior of the wheel; it works out and when it comes to the edge of the flange it goes, and it seems to go sooner with the hundred thousand capacity car than any other, and for the reason as pointed out in the paper, that you have a very heavy brake shoe friction on the wheel, especially on long mountain grades; the wheel is heated to a high temperature and those cracks are developed in the inside. Now, if instead of making the thermal test with 1½ inches of molten iron it is made with ¾ inch, cracks are apt to be started on the inside of the wheel, showing that the excessive heat that obtained from the ordinary thermal test is too much to develop the crack, because it thoroughly heats the rim and body of the metal well down even into the web.

In doing the work I have been engaged upon, I found in cutting up the tires and steel wheels, that it was merely a matter of getting the saw in such a shape that it would cut through that exceedingly hard and tough metal; other than that we had no difficulty. There was difficulty enough there, but that was the principal one. When I came to cut the cast iron wheels, I found there was another thing that entered in, that the wheels did not retain their shape after they had been cut. I did not suspect anything of that kind until I had mutilated the wheel when it was too late to take any exact measurements. But my impression gained from cutting up these wheels and watching their behavior is that there is a very decided internal stress in the rim of the cast iron wheel.

I accidentally happened on a test the other day, a drop test, in which a cast iron wheel broke in a very peculiar way, broke in a way in which I have never seen one break before, but broke so as to show

that that wheel at least had a very decided internal stress in it. Now, if a brake shoe is put on the outside of such a wheel, and heats it up, it simply adds to those stresses and the breaking stresses of the metal are apt to be exceeded and those internal cracks are developed. That is a tentative explanation of it. I have no data to prove it, but it looks reasonable to me from what I have already seen, so that it is the combination of the heavy load on the wheel, the brake shoe pressure and then that exceedingly great lateral thrust that comes onto the wheel when we are rounding curves.

I thought some six months ago that the stresses on the curves were the points where the greatest amount of strain was put upon the flange. I am not so sure of that now. I have been doing some work on tangents, and I have had some cases right there that make anything I have had on curves drop into absolute insignificance, so that I am inclined to think it is quite possible that you get your heaviest blow on a tangent where your car starts nosing, but do not know as yet. Turning now to the point of the shape of the tread and the flange; Mr. Bush's suggestion of a modified tread and a modified coning for the approach to the flange is in exact accordance with certain experiments that have been conducted.

In regard to bad riding passenger cars, in two or three instances I have known of bad riding passenger cars that would ride all right on curves, ride all right on ordinary tangents at an ordinary speed, but when the speed ran up to fifty or sixty miles an hour, they would begin the nosing motion to such an extent that in one or two instances it was considered dangerous. Everything was tried in the way of changing the springs, but the final remedy that met the whole trouble was to put a cylindrical tread on the wheel. That is exactly what Mr. Bush proposes to do, to put a cylindrical tread on the wheel and then to cone it off so as to keep it away from the flange when the flange would have come up against the side of the rail. That appears to me as a most reasonable proposition.

In regard to this nosing, we know what it is on a passenger car and an electric car (and very few people ride on freight cars, and they ride so bad anyway that it would not be noticed,) but I think one of the reasons for the high percentage of wheel failures on freight cars, as given here this evening, compared with the percentage of passenger cars, is possibly due to that nosing effect. The nosing effect has been found to increase as the distance between truck centers is decreased so that the shorter the car, the more liable it is to nose when it gets on a tangent, hence it is more apt to occur on a tender than it is on a freight car, and I have heard it suggested that a great deal of trouble with derailments which occur on the tender is due to the fact that one wheel drops in a low spot, and the tender commences this nosing action and leaves the rails. I have known it to occur on tangents as well as on a curve.

In regard to the effect of side bearings, I think the easier the car curves on its side bearings, the more likely it will be to square itself on the tangent. I think that if you will measure most cars that are down on the side bearings, you will find that they do not square at all on a tangent. I once had some trouble in this direction with an experimental car. I told my woes to Mr. P. H. Dudley and he said that in his dynograph car, that was carried on carefully finished center plates and plain side bearings, he found it utterly impossible to get those trucks to square under the car on a tangent until they struck a tangent running in another direction. I hunted the matter up somewhat and I found too that a clearance between the side bearings on the side of the car is a bad thing. Of course under ordinary car construction, it is impossible to get three points in a straight line, so as to get the side bearings and center plates all in contact, and the result is that it is necessary to have a little clearance on the side bearings, but I think the less it is the better. The reason for this, is explained by some work I did some time ago, in order to ascertain the stresses or loads which were put on the center plates and side bearings while the train was in motion. I found the loading on the side bearings when we struck a curve was increased very materially by an increase in the original clearance. The car got over there and simply laid down on the side bearings and stayed there until we were well off on the tangent, so that the truck could not get back and square itself after leaving the curve.

That brings up the question of course of the value of the ball bearing as compared with the ordinary center and side bearings, and in regard to the stresses to which the wheels would be put on the curves when running at different speeds. That is a matter on which I do not know of any data in existence at the present time, but there is every prospect that we will have something in time for the Master Car Builders' conventon in June, as showing what the real effect is when we get right down to the flange of the wheel.

There is another matter in connection with the weight on car wheels, which I think has been overlooked to a great extent, and that is the excessive load that is put on the wheel when it is running. In measuring the bolster stresses referred to, I got from 25 to 30 per cent over my static load when the car was running about twenty-five to thirty miles an hour, and that extra impact was applied about three times to the second. Whether it is a coincidence or not it is worth noting that these extra impacts coincided very closely with the passage of the wheel over the rail joints at the speed named which was at the rate of about three joints to the second, so that may have been the influence in control. At any rate, it is apparent that the load the wheel is obliged to sustain, located as it is, below the springs must be greatly in excess of the simple static load when the bolster which was above the springs was carrying from 25,000 to 30,000 pounds, as a

total load at that time. That means the question of the pounding of the wheel against the rail.

In regard to the matter of the development of the cracks in wheels and the development of the breakage of the steel wheel due to the breaking off of the flange, it is quite possible that they might occur from slag or impurities in the metal. I could only find two causes for the shelling out of the steel wheel; one was slag and the other heating. Either of those causes might develop a crack and of course if we got a crack started anywhere, whether it be from slag or overheating of any steel wheel, it will gradually grow and work until finally the flange will break off; but brake shoe action I do not think causes any effect on it for the reason that the metal is so much stronger to start with. You take cast iron and you can get 22,000 pounds tensible strength—it will be good metal—but most wheels will break, at from 17,000 to 20,000 pounds per square inch. In the matter of steel tires and wheels I went through everything that was on the market, and did not have anything that broke up at less than 112,000 pounds, and further than this you will understand that there were absolutely no detectible or no noticeable internal stresses, whereas in the case of the cast iron wheel, starting out in the first place with a low tensile strength probably not exceeding 18,000 or 19,000 pounds, and with that internal stress in the inside of it all ready to help things along and start those cracks the moment the brake shoe heated it up, it is small wonder that breakages occur.

Of course the point that Mr. Schroyer brought up in regard to the economy is a matter that every railroad must consider and the relative value between the steel wheel and cast iron for high capacity cars is one that each road must work out for its own salvation and calculate upon such a basis as it may consider proper. There are innumerable ways of doing that, but it seems probable that the ordinary good steel wheel ought to outlast about seven cast iron wheels. There is very little data to support that assertion other than the investigation in regard to the general characteristics of the wheel, except that recently it has been found that on one large coal line where the cast iron and steel wheels have been put in direct competition with each other under cars running identically the same, that the steel wheels ran about 40,000 miles without turning and showed no need of it, while two pairs of cast iron wheels have been worn out and discarded, showing a mileage of about 20,000 miles. The reduction of the mileage to which attention has been called in the paper is, of course, very serious but that is no more than what is to be expected when the camel is overloaded and the high capacity cars are considered. I think the question is a matter not only of original expense, but of safety to the railroads. I know in one case a superintendent of motive power, speaking of the subject, said he considered it was decidedly dangerous to use a wheel under a car that was likely to break

because of its danger to the passenger service. That on a heavy traffic line the passenger trains were spending so much of their time passing freight trains that an accident on the freight train would be more than likely to be disastrous to the passenger train running alongside of it, and for these reasons and for the reasons which I have set forth in the publication which Mr. Bush has referred to, I am decidedly of the opinion, personally, that a steel wheel is very much to be preferred to a cast iron for high capacity cars and that really a 100,000 capacity car is overtaxing the cast iron wheel.

President Seley: Is Mr. Griffin in the room? May we hear from him?

Mr. T. A. Griffin (Prest. Griffin Wheel Co.): Mr. President and Gentlemen of the Western Railway Club: The subject is too large and the time too short to permit of going into very much detail tonight. The question, as I understand it, is you have very serious trouble with the breakage of the flange on your cast iron wheels and information is sought how to prevent it or stop it as far as possible.

As far as I know, the difference between the steel and the iron wheel is as yet an untried proposition which time alone will demonstrate. I could tell you, if I had the time, what I think is one of the primary reasons for the trouble in the breaking of the flanges of the wheel. In the casting of the car wheel, the iron goes into it from the center of the mold and rises through the brackets, comes to the rim of the wheel and gradually fills up until it comes to what we call the throat of the wheel which is formed by the chiller, which, reaching over the hot iron, must heat the iron that is in the flange of the wheel that is cooling, and after it gets up past the throat of the wheel, the iron that is below that point is already set and undisturbed and is cooling and shrinking. The shrinkage on an iron wheel is about one half inch, the chill is 33½″ and the wheels 33″ when finshed; the shrinkage on the wheel is beginning before the throat of the wheel is filled. There is a strain in that shrinkage that is always there, and is pulling the rim of the wheel in, and when the wheel is finally cast, the iron, as it stands in the mold, that is the iron that is right at the point of the flange, has already left the chiller probably 1/16″ as the iron is filled. The iron at the throat which forms the ribs of the wheel is as hot as it is at any other point, because it is at the hotter portion of the chiller, therefore the metal at that point is softer and it is still soft when the strain of the shrinkage is developed by the flange being colder than the rest of the wheel. That wheel always has that strain on it and possibly there is no way by which it can be entirely removed. The effect of putting extra metal in the back of the flange, as has been thought of by the Master Car Builders' Association really does not affect that, although they seem to think it does, because the extra amount of metal which is put at the back of the throat of the

flange has a tendency to keep the metal hot at that particular point more than if it is thinner, and the same result is obtained if a crack starts in the throat of a wheel. The added thickness of one half inch is not going to stop the crack from going through, and therefore the value of that is lost as a final result and it is of no advantage as a starting point. I was going to say that when the brakes are applied to the car wheels, the friction that is developed from the brakes and the friction that is developed from the flange of the wheel in contact with the rail has a tendency to develop heat in the flange of the wheel more than in any other part; that flange commences to expand; the only way that the flange can expand is out and when it expands out it is reproducing similar strains to those brought about by the contraction; in other words, the strain is acting on the weakest spot. You cannot find the crack in any wheel when the metal is cast, but there is a strain there and when you put the brake shoe on the wheel, the friction and heat that is developed by the contact of the rail and the friction of the shoe, which is against the flange of the wheel, generally superheats the flange of the wheel in proportion to the rest of the wheel and the expansion is most unequal through it. That is detrimental to the iron wheel, but it is true, and the question is, what are you going to do to stop that? I do not know of any way in which you can stop it. It can be improved a great deal in the manufacture of the car wheel, in the process, and the chill that is developed. As a matter of fact, under the present condition of power, if the wheel maker were to make his wheel very soft, his wheel would be the one with the sharp flanges and would be more apt to slide flat, and he would not have any wheels to replace. The great trouble with the wheel maker is that he may know, and when I say "he may know," that is comparatively true, when you stop to think that not in any public library or private library in the world can you find any authority on the subject of chilled iron car wheels. If there is any I have never heard of or seen it, and the reason for that is that it is, comparatively, a new proposition; it is not much more than well, sixty or sixty-five years, since the first iron car wheel was made. It is made on peculiar lines; people at large had no chance to study the subject except men who were actively engaged in that particular line, and they were few and they handed it down from father to son with a wise look; they found by using certain grades of iron they could produce certain results, but none of them knew the reason why; they did not have the scientific data, nor did not know enough to know why, if they did certain things, they got certain results. It is of no value to produce anything unless you know the reason why, and, with all this complicated situation, the flange of the wheel is just the size that it was fifty years ago, while it carries fifty tons running twenty miles an hour, where it used to carry less than half that amount running ten miles an hour. The wheel cannot really be improved upon, and

the only thing I can see for the railroad people to do in regard to this matter, is to exert themselves in every possible way to relieve this great strain upon the car wheel. I do not pretend to say whether you are going to do it by the coning of the wheel or the size of the bearings, or something of that kind, but there must be an effort to do something. Railroads have had a great deal to say about the car wheel; what it should be made of and what it should be made in, but what do they know about it compared with the man who spends his life on it, and yet railroads say they put the wheels in service, they say all wheels must be alike, because we ask you to give us a certain guaranty for strength, a certain guaranty for thermal test, a certain guaranty for chill and you have guaranteed the wear of it, and if you can do that, we cannot see that there is any question of quality and if the test wheels stand the test then they must be all alike. You might as well examine a man's lungs and find them good or bad and then declare the next one hundred men's lungs are good or bad as you found the first man's lungs. You take a wheel and put that into service under your car and you have a guaranty and you rely on the guaranty the wheel maker gives; that it is good; the wheel maker says it is a good wheel; you put the wheel into service for five or six years, and you have a record of mileage if it is under a passenger car, you have a record if it is under a freight car. If the man takes the wheel out, he looks up the mileage and you say, "How long has this wheel been in service?" Well, this wheel has been guaranteed five years, and it has been in service four years and nine months; "well, have the maker replace it." "How long has this one been in?" "This one has been in five years and a month." "Well, that is all right." So we examine one hundred wheels and select two wheels of the one hundred to base our opinion on the quality of that lot of wheels and you do not know whether they made 50,000 or 90,000 miles, or what their service was, and to the extent of 98 per cent of the car wheels that are removed, they do not know what they do. I am not saying this in criticism; I think the railroad people must pay some attention to a subject that is of so vast importance to them as this. I am not talking from a chilled iron standpoint; I told a railroad man who said the steel wheel will supplant you, "I am not interested in that; I am not making car wheels for the privilege of making a lot of cast iron wheels; I would rather make five dollars on a steel wheel than fifty cents on an iron wheel." Certainly there is no prejudice on my part in comparing it, in fact, it is not my intention to refer to steel wheels at all, but what I say to the railroad companies is not, what remedy have you got to suggest? my remedy would be this,—study the subject.

Mr. Fowler has done a great deal in developing knowledge in regard to the steel wheels and other wheels and I wish there were hundreds of people on the railroads today spending as much time finding

out what iron and steel wheels are. Then the end would be that the best man would have the best results. What I object to principally is that there is no inducement to an iron car wheel maker, and I do not know that it is better with the steel wheel maker. Whenever the purchasing agent is called on, (and I do not blame him), he is told by the railroad people to buy the best wheel he can so far as he knows; he is not supposed to have any judgment; there is the specification and there is the blue print, buy the wheels. There is nobody behind him to tell him what to do. They do not know; the railroad men would like to know, but they do not; it is only by experience they can know. I can tell you a lot of stuff about my wheels being better than anybody's else. I can tell you that there are one hundred things that affect an iron car wheel in its manufacture. I will guarantee to take the best iron that is made, put it in the cupola and bring out the rottenest stuff that can be found anywhere. Now, what do we do? Why, it is a very peculiar proposition. Here is a metal that has in it and has to have in it both kinds of carbons, graphitic and combined; it must have silicon; it must have a certain amount of phosphorus, a certain amount of sulphur, and a certain amount of manganese. All those things form the necessary constituent parts of a car wheel. The car wheel that will stand the test best will stand the worst for wear, for the strength is sacrificed. Here is a combination that you must have, because it has to stand extreme heat and extreme cold. You are apt to go down a mountain with your brakes set and your wheels almost redhot and stop in the snow around the depot; one third of the wheel will start cooling off rapidly and the other cools slowly, forming a variation and uneven contraction at the point where the cold is the greatest; run that wheel along, and the first thing you know, you strike the projecting end of a frog and hit it with the wheel, knocking a piece out, and you say, "That is damned poor stuff the wheel maker put in." (Laughter.)

Now, what I am trying to say and to get through as soon as I can, (I could talk for several hours), I have been in the business for forty years, and when I was in it ten years I thought I knew more than I know now after thirty years experience. But as I say, the only thing which I have to advance is not to impart any particular knowledge, although I have spent a lifetime watching it, it is not that that is going to do it; I cannot lay down any rule that is going to make a car wheel; I cannot set up any mixture that any one should be compelled to put into the cupola, so much silicon and so much carbon and one hundred things that have to be thought of. What I have to get at, is to do everything possible to keep the chemical qualities in the iron and keep my temperature at a certain heat, neither too hot nor too cold. If it is melted at too great a heat the chill is affected, and after I get through with all those things, which I could enumerate if I had several hours to go into details, I take the wheel out of the

cupola and carry it to my mold; I pour it into the mold, and if I do not pour it into the mold hot enough, it varies the chill; if I pour it into the mold too hot, it varies the chill; it may be either too much or too little according to the chemical composition of the iron. If the sand is rammed too hard, the iron is going to be affected, and if it is too soft it will swell; if the core is too hard the iron will not lay to it, and after we have done all that and the chill is taken off the wheel too hot, the chilled section reheats and the chill becomes soft; if we leave it on too long, the chances are too much of a shrinkage is obtained on the wheel; it will never get back again. and there is a strain on the wheel; if you take it out of the mold too hot, it will bleed, and if we take it to the pits and the pits are not hot enough and a sufficient amount of space used to equalize the heat and bring back the heat on the tread of the wheel, then the tread is bad. Then to get it out of the pits, if it is cooled too fast another strain is developed. Now, you need not tell me that all those different variations result in laying down a rule in regard to mixtures. It is constant watching and care all the way through. You know something about one wheel that will break, but you do not know anything about the ninety-and-nine, and it is your business to know which car maker knows about the ninety-and-nine, and it is your business to watch the wheels that come off your road and to watch the 98 per cent and not the 2 per cent. You know that you can get a list sent in; you can do it in thirty days, but thirty days would not be reliable; but every thirty days that elapse you get in a certain lot of wheels and say, "Mr. Smith has a great many wheels, with broken flanges, Mr. Brown has not got any." Mr. Smith may have but very few wheels to get worn, Mr. Brown may have a lot; it may be the reverse, possibly, but make a note of the number of wheels, subdivide them, and see which has the most trouble; keep a record that is full and complete if you want to arrive at the wearing quality. I think that is not up at this meeting, but that is something that you can find out if mileage records are closely watched, and the date is cast on every wheel, and it is fair to say that the wheel is put into service within sixty days, whether those breaks are eight or twelve years old, or two months old, there is a decided difference if a car wheel breaks after it has been in service five or six years, you can say that it is not the fault of the wheel. Yet if a car wheel breaks within a year or two, then you know there is some fault or it has had bad service. Now, you can not help the bad service by issuing orders for an article that cannot be strained, but what I would like to have the railroad people do is to study up the subject and realize how important it is that a thorough knowledge and careful attention to every detail of the subject is had, where you do not know by looking at one what the other hundred are, and may be you can get to a point where you can say to your people, "all car wheels are not alike and some are worth more than others." I

am not talking about the process; it is not what you put into the car wheel at all; it is a good thing to start with a good article; that lessens your chances of bringing out a failure, but there are ninety-nine other things to be considered by the railroad people. I think it would be a good thing for them to organize among themselves, not to figure out and tell the car maker what mixture to put in, but to send around to the different makers and find out who is running on a good business basis to get the best results. The result is that if he is a good business man he will not send out his bad ninety-and-nine, but when a wheel maker is expected to turn out a good article, he cannot afford to throw away much.

MR. SCHROYER: I observed that Mr. Griffin looked at Mr. Woods and Mr. Manchester all the time he was talking.

THE PRESIDENT: Is there any further discussion?

MR. J. J. HENNESSEY (C. M. & St. P. Ry.): I am a little bit surprised at the trend of the discussion here tonight. It has been my fortune to railroad something like thirty-six years and I can say candidly that we have not had as many flange failures under 100,000 pound cars as we had under 30,000 pound cars thirty-five years ago, and, consequently, I think the wheel manufacturers are entitled to a great deal of credit for the advance they have made in cast iron wheels. That does not say that it is impossible to make a better wheel than they are making now, but I think the wheel manufacturer has been laboring under many difficulties. Just as Mr. Griffin said, they have to accept from many roads a scrap wheel as part payment for every new wheel purchased.

I think the correct thing for the railroads to do is to buy wheels that are guaranteed against all fair service failures for certain periods and not buy the cheapest wheels regardless of quality.

There are so many things that cause sharp flanges that it would take possibly half an hour to enumerate. The trucks may be out of square; the car may be too heavy on side bearings, although I do not believe that either of these causes cut much figure in flange wear, because if it did you would have worn flange wheels on diagonal corners of your truck, or you would have two sharp flange wheels on same axle, and this certainly is a rarity.

In my judgment the principal cause of worn flanges is due to the different wearing qualities of the wheels on same axle. As to breakage of flange, I am firmly of the opinion that cars should not have too much clearance between side bearings, for the reason that where the car first strikes a curve excessive clearance of side bearings would cause the car to lunge to that side and prevent curving just at the instant when truck should be free to curve. This causes excessive shock on the wheel flange, and it seems to me, if there was more use of anti-friction side bearings and center plates, it would reduce the number of broken wheel flanges.

The failure of the flanges is not confined alone to cast iron wheels.

and in reply to Mr. Fowler, when he said that cast iron wheels were taken out after making about 20,000 miles of service, I think if that were true, it would practically put the railroads out of business. There may be an exceptional wheel that is taken out after 20,000 miles of service, but they are very few. Now, I suppose there are about a hundred men that want to speak on this subject tonight, and I will not say any more just now.

Mr. J. F. DeVoy (C. M. & St. P. Ry.): I just want to draw attention to one fact and that was brought out by Mr. Hennessey, the last speaker. He was almost alone in his statement at the last Master Car Builders' Convention when he said that additional coupler clearance would have an effect on flange wear of wheels, and that it would be detrimental to the wheel. Mr. Fowler said to me today that he did believe that additional coupler clearance did impose additional load on the flange of the wheel; he thought that that was true. I merely want to bring that out tonight, because we stood alone on it at the last Convention. I believe it is true, and I still believe that he is right and that additional side clearance ought not to be given on this account.

I want to say in conclusion that I know of 7,000 cast iron wheels, that made over 53,000 miles, and I do not want to say anything against the cast steel wheel, but you have to get a pretty fair cast steel wheel that will make that mileage, and if a cast iron wheel made 53,000 miles to a certain cast steel wheel making 63,000 miles, there must have been few flange failures in the cast iron wheels and it is my honest belief that the end of the cast iron wheel is not yet.

Mr. P. H. Peck (C. & W. I. R. R.): I have nothing much to say. I am no technical man but would like to inquire of the technical men present, what percentage there is in a car wheel? The paper this evening says about 85 per cent are removed on account of sharp flanges. I was at a meeting of a committee on Maintenance of Way a short time ago when the question of slit flat spots came up and representatives of some roads stated that 25 or 30 per cent are removed on account of sliding. Another Master Car Builder said that 15 per cent are removed on account of chipped flanges and broken rims. This makes 130 per cent removed, and that is the reason I ask the technical men the above question.

The President: Mr. Bush, will you close the discussion.

Mr. Bush: Mr. President and Gentlemen, I made a few notes as the discussion was going along and I will try to confine my remarks to the points that have been made.

Mr. Hennessey speaks of the fact that he does not think there are as many flange failures now as there used to be. That may be true as far as Mr. Hennessey's experience goes; my statements are based on information I have obtained from several railroads. I have not confined myself to one railroad in any matter discussed in my paper I cited the fact that on one railroad there were over 3,000 wheels re-

moved with these seams during the year, every one of which might have been the cause of a broken flange and in addition to those 3,000 wheels there were over 1,000 on that particular railroad that had the broken flange as a result of seams, and I said in my paper that that condition prevailed on certain other railroads, and it does. These are matters of personal observation very largely, as well as records.

Mr. Griffin spoke on the causes of failures. As I said in my paper, there may be differences of opinion as to the exact cause of failure of the flange. I give one explanation, Mr. Griffin gives another. In my paper I said that a certain wheel manufacturer told me that internal stresses may exist in wheels, depending on the process of manufacture. Mr. Griffin says that that is the case. I would not undertake to dispute him at all, because I think he knows more about that than I do, but the fact remains that the wheel does give out in a certain locality. That locality I have shown. I have shown by one of the diagrams that it exists close to the flange and sometimes a little farther from the flange, and the fact that in some cases it takes place a considerable distance from the flange confirms me in the belief that it is due largely and principally to the application of the concentrated load and concentrated heat rather than the result of internal stresses, but I am entirely willing to agree with Mr. Griffin that those internal stresses may take place.

Mr. Griffin has quite a little to say on the quality of wheels, and from my observation I think that what he has to say on that subject ought to be taken very seriously indeed. There has been a great deal said about improving the quality and how to improve it. Some say, use more charcoal iron. Mr. Griffin has explained how you may use the very best quality of metal to start with and yet produce poor wheels and this I know to be correct. There are a great many opportunities for losing the benefit of superior raw materials in the process of manufacture and it is not necessary for me to explain all of them. But it seems to me that if the question of cupola practice were studied by the users of wheels; if they had some experts, some men they could designate to study this subject, follow the question up, and I might say that cupola practice as a practice is far more susceptible to variation than is open hearth practice or Bessemer practice in the making of steel, or the crucible practice, and therefore greater attention should be given to the cupola practice.

Then he points out there may be a great many variations as the result of foundry practice; some foundry practice may be good and some foundry practice may be bad, and so it is in the process of annealing. It would seem that there should be intelligent co-operation on the part of railroads and on the part of manufacturers and that the manufacture of wheels should be reduced more to an exact science than is the case oftentimes. I am sure manufacturers will do all they can to aid the railroads so far as their facilities go, and I would say that the wheel manufacturer who has reduced his process more to an

exact science is to be relied upon more than the man who has not. Information on this subject is not at all general. There is no literature on the chilled iron wheel. The man that can tell you about it intelligently is a better manufacturer than the man that can not. It is a fact, as Mr. Griffin and Mr. Schroyer say, there is great variation in the quality of wheels. I have found in going around and breaking up wheels, breaking off the flanges that some flanges come off without any trouble and some others come off with a great deal of difficulty, and if you examine the wheels after they are broken, you can see the difference.

Mr. Griffin also spoke of the question of railroads having no records. It seems to me that if we are going to operate intelligently, it is absolutely necessary to know what kind of results you are getting from different kinds of wheels. There are no records today to speak of beyond the time which the guaranty lasts or the guaranty is given for. It is a fact, as Mr. Griffin states, that little is known of wheel service beyond the guaranteed time, and I should think it would be highly important.

Now, two gentlemen have spoken here to the effect that they did not believe that anything in the way of relieving friction center bearings or side bearings amounted to anything. I can only say that I have been particularly cautious in approaching that subject, and I have relied in a measure on what railroad men have told me, and the information that I get from steam railroads, such as have really tried, and also from street railways and interurban railways, is to the effect that the introduction of something that will reduce the resistance to the pivoting of the truck very materially reduces the flange wear; it very materially reduces train resistance. I know that many railroads have made tests of trains having cars where the side bearings were clear and uniformly they report there was a great reduction in train resistance. Now, I do not know what else you can attribute such results to, except the fact that the trucks track better. If the trucks track better, it is going to relieve the flanges. My position is based enirely on facts as I have gotten them from those who have tried them out in a comprehensive way and from my own observation.

Mr. Schroyer's argument was to the effect that you would probably have sharp flanges on both wheels on the same axle if we used anti-friction bearings.

At one point in my analysis I stated that where two wheels mounted on an axle, were not of the same circumference, the tendency was for the wheel of larger diameter to roll away from the flange and the wheel of smaller diameter roll to the flange; that influence is always present and I am prepared to agree with Mr. Schroyer on his point to this extent, that if after passing around a curve the truck does not straighten out and relieve the flange of the wheel of larger diameter that it may run to the flange for some time, but I maintain that it will not run to that side nearly as long or with as much pressure as it

will in the reverse case; in other words, there is always a greater tendency for the larger wheel to drive the smaller wheel to the rail. If the coning of the wheels was permitted to perform its intended purpose originally by having less resistance to overcome then flange wear would be reduced.

I have been particularly careful to state that I do not think there is any one thing that will remove all of this difficulty, not by any means, because you may have two wheels on one axle, one having a chill harder than the other and the latter will wear faster. In cases of that kind you will have a sharp flange regardless of what may be done to prevent it, but I believe that to reduce the resistance to pivoting will greatly alleviate the difficulty. Briefly I state that ability of wheels to track is a better condition than inability so to do.

Mr. Schroyer also spoke of the fact that most of the wheel flanges that fail are those from wheels that are worn sharp. I have some here that are worn sharp that are broken off and some that are not but the majority of those I have found are those from wheels that were worn to the flange. I have one sample here which shows that the flange is hardly worn at all, yet it has developed a seam and broken, and so I attribute the influence of heat on the periphery of the wheel concentrated at or near the flange as one of the elements that brings it about.

Mr. Schroyer stated also that failures of flanges are found more in certain makes of wheels. There seems to be no doubt of that fact; my investigation demonstrates it. There are some makes of wheels that break a great deal more frequently than others, although I can say that I find practically all makes of wheels with broken flanges from the same cause apparently.

Mr. Barnum and Mr. Fowler spoke of the fact that in passenger service the wearing of flanges was not as great as it is in freight. That is true, I can confirm that by my experience, and Mr. Fowler's explanation seems logical. My own idea of it is that almost invariably in passenger service the truck has a great deal longer wheel base, and therefore if there is any pressure out at the wheel flange it must be less than with a shorter wheel base and the truck with larger base will track better. Also it can very much more readily overcome the resistance to turning on account of the greater leverage and therefore the coning of the wheel would be more effective in keeping the flange away from the rail. This rather confirms my statement that if the resistance to pivoting of freight truck were less, the wheels would track more readily.

One gentleman spoke of the use of charcoal iron. Now, it is a common belief that you have got to use charcoal iron; that has been the belief for years, and in order to get a good quality of wheel it is necessary to use a higher per cent of charcoal pig. It is not generally known why this is, but is, commonly accepted. Now, one peculiarity about charcoal pig iron is that it has little sulphur in it. Sulphur is

one of the elements that goes to make brittleness. When you use charcoal iron, you reduce the content of sulphur. If you should use coke iron and cut the content of phosphorus and sulphur down, you get the same result. You cannot use charcoal iron in large quantities today, because it is not made and it would be unnecessarily expensive, but you can have always an abundance of coke iron.

Mr. Manchester referred to the use of the contour that he has on the Chicago, Milwaukee & St. Paul road, and says that he does not believe that the flange wear has been reduced. It seems to me he may be entirely correct in that. I do not think that that contour can be expected to eliminate flange wear. I have endeavored to point out that something else is necessary to assist any contour but that the coning he provides near the throat is better than coning the entire tread. I stated that a wheel if coned originally will in a short time wear out the coning. As a matter of fact probably 95 per cent of all the wheels in service have no coning except that adjoining the fillet at the base of the flange and this conforms in a measure to the rail head and is much steeper than one in twenty and therefore more effective.

Mr. Garstang speaks of my proposed contour as eliminating the coning. I have already spoken of that. He also speaks of the area of contact shown in my Fig. 2. Of course I realize that as a matter of fact in practice you do not get such a theoretical condition as shown in Fig. 2, because the rail yields under the pressure and he speaks of the area of contact as being one fifth of an inch under 19,-000 pounds. Now, while the area of contact may be 1/5″, that is not a very large area; it does not necessarily mean that there is an equal pressure over all that 1/5″. As a matter of fact, the pressure is very decidedly concentrated in the center of that 1/5″.

Mr. Schroyer: I want to say a word right here as regards this discussion of the wheel. There are a great many here that have not spoken who I am sure would like to speak, and I would like to make a motion that the subject be carried over and be taken up at the next meeting. We are in the dark now as to what we shall do, as to whether we shall on our heavy capacity cars continue the same wheel or whether we shall discontinue the cast iron wheel. I think we ought to keep up this discussion until we find out something about it.

The President: Moved and seconded that the discussion of this question be carried over to the next meeting. All in favor, signify by saying aye. (Motion carried.)

The President: Your Chairman has refrained from taking part in the discussion mainly to give a chance to those who desired to speak this evening. I have something to say on the subject and that will be deferred until the next meeting, as proposed by Mr. Schroyer. We have another paper this evening, gentlemen; what is your pleasure?

Mr. Schroyer: I move that the other paper be taken up in order at our next meeting. Motion carried.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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Library, 390 Old Colony Bldg.

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, February 18, 1908. President C. A. Seley in the chair. The meeting was called to order at 8:30 P. M. The following members registered:

Bourne, G. L.
Barnum, M. K.
Bush, S. P.
Carlton, L. M.
Carney, J. A.
Carroll, J. T.
Clark, F. H.
Clark, R. B.
Dangel, W. H.
Davis, G. G.
Delaney, J. H.
De Voy, J. F.
Dewar, J. I.
Dodd, T. L.
Dow, Geo. N.
Eckels, C. P.
Elliott, P. M.
Fenn, F. W.
Fogg, J. W.
Fowler, W. E. Jr.
Garland, T. H.
Garrett, C. M.
Garrett, M. A.
Gilbert, E. A.
Gold, E. H.
Goodwin, G. S.
Harkness, F. L.
Harahan, J. T. Jr.
Harris, D. T.
Hayes, R. F.
Hinckley, A. C.
Houchin, B. F.
Hunter, P.
Jeffries, B. H.
Jenks, C. D.
Keeler, B. A.
Kelley, H. D.
Kellogg, W. L.
Kennedy, Chas.
King, C. H.
Kucher, T. N.
Lawson, W. C.
Lockwood, B. D.
Lowder, R. S.
Lucore, F. M.
Manchester, A. E.
MacKenzie, D. R.
McAlpine, A. R.
McCarthy, M. J.
Midgley, S. W.
Milner, J. T.
Mohle, C. E.
Morris, T. R.
Motherwell, J. W.
Naylor, N. C.
Parks, R. H.
Pflager, H. M.
Pratt, E. W.
Runnells, Clive.
Russum, T. H.
Ryder, G. E.
Schlacks, W. J.
Schmidt, E. C.
Seley, C. A.
Seymour, J. B.
Shults, Chas.
Smith, H. E.
Sullivan, C. L.
Symons, W. E.
Taylor, J. W.
Thomas, W. D.
Thompson, W. O.
Walker, E. H.
Weatherly, R. H.
Webb, E. W.
Whyte, F. M.
Willcoxson, W. G.
Winterrowd, W. H.
Woods, E. S.
Woods, J. L.

The President: The meeting will please come to order. I regret very much the carelessness of the Secretary in providing such

a brand of weather as we have this evening, and I think everybody present ought to have his name in the paper, and if you will be kind enough to put your names on the cards at the door, we will see that they get into the proceedings.

The proceedings of last meeting having been printed and issued, will be approved if there are no corrections. There being none, they are approved.

The report of the Secretary is next in order.

THE SECRETARY: Mr. President, I have the usual membership statement.

Membership, January, 1908	1,440
New members approved by Board of Directors	18
Total membership	1,458

Name	Business Connection	Address	Proposed by
Wm. Jappert,	Car Foreman, C. B. & Q. Ry.,	Lincoln, Neb	Wm. Baird
I. W. Darby,	Mather Stock Car Co.,	Chicago, Ill	W. B. Hall
R. S. Alsdorf,	Draftsman, C. R. I. & P. Ry.,	Chicago, Ill	G. S. Goodwin
C. L. Buckingham,	Draftsman, C. R. I. & P. Ry.,	Chicago, Ill	G. S. Goodwin
Chas. Kleeman,	Draftsman, C. R. I. & P. Ry.,	Chicago, Ill	G. S. Goodwin
J. O. Neikirk,	Rodger Ballast Car Co.,	Chicago, Ill	Carter Blatchford
H. L. Cole,	Sales Mgr. Bradford Draft Gear & Mfg. Co.,	Chicago, Ill.	M. K. Barnum
W. A. Stearns,	M. E. L. & N. R. R.,	No. Louisville, Ky	F. W. Fenn
A. F. Walsh,	Draftsman, Ill. Central R. R.,	Chicago, Ill	G. F. Axtell
O. M. Olson,	Spencer Otis Co.,	Chicago, Ill	Carter Blatchford
C. J. Humphreys,	Spencer Otis Co.,	Chicago, Ill	Carter Blatchford
C. F. Leppla,	Draftsman, C. R. I. & P. Ry.,	Chicago, Ill	G. S. Goodwin
R. I. Graves,	Spec. App., C. & N. W. Ry.,	Chicago, Ill	H. D. Kelley
J. Soule Smith,	Amer. Steel Fdrs.,	Chicago, Ill	D. T. Harris
J. R. Stuart,	Amer. Steel Fdrs.,	Chicago, Ill	D. T. Harris
Clive Runnells,	McCord & Co.,	Chicago, Ill	W. J. Schlacks
Jas. H. Delaney,	Western Elect. Co.,	Chicago, Ill	Percival Hunter
Jno. I. Dewar,	Spec. App., C. & N. W. Ry.,	Chicago, Ill	H. D. Kelley

THE SECRETARY: Mr. President, this is the month in which a committee on revision of rules of interchange of the Master Car Builders' Association should be appointed; the Executive Committee has named the following committee:

Henry LaRue, M. C. B. C. R. I. & P. Ry.
O. M. Stimson, M. C. B. Swift & Co.
J. W. Fogg, M. M. Chicago Ter. Transfer Ry.
H. H. Harvey, G. C. I. C. B. & Q. Ry.
T. H. Goodnow, M. C. B. L. S. & M. S. Ry.

This committee should report at the April meeting of the Club.

THE PRESIDENT: The Secretary will notify the appointees.

THE SECRETARY: I have a communication, Mr. President, which applies more particularly to the members of the Western Railway

Club who are members of the Master Car Builders' Association. This is from Mr. W. E. Symons, Chairman of the Committee on Subjects of the Master Car Builders' Association.

Chicago, February 14th, 1908.

Mr. J. W. Taylor, Secretary, Western Railway Club, Chicago.

Dear Sir: The Master Car Builders Committee on Subjects have been favored with an advance copy of a Resolution, which will be presented at the next meeting of the New York Railroad Club with respect to standardizing certain materials entering into the construction and repairs of cars.

The information is of considerable value to the Committee, and prompts an inquiry to all of the Clubs with a view of securing additional information of a similar character, which will aid us in recommending subjects for next year's consideration.

If you will kindly favor us with such suggestions, as you may have to offer with respect to this matter, either from the Club, or from individual members thereof, the Committee will highly appreciate information thus furnished, and will be glad to consider the same in making our recommendations to the Convention.

As the time for the Annual Convention is fast approaching, we will very much appreciate as early a response as is consistent in the premises.

Kindly send replies to the undersigned, No. 914 Postal Telegraph Building, Chicago, Illinois.

Respectfully,

W. E. Symons.

If any of the members of the Western Railway Club who are members of the Master Car Builders' Association have any subjects which they would like to have considered by the Master Car Builders' Association, it would be well to suggest them to Mr. Symons, who is chairman of the Committee on Subjects. Mr. President, those are all the communications I have to read at this time.

The President: I might add to this last notice that I am Chairman of the Committee on Subjects of the Master Mechanics' Association and would appreciate any suggestions from any member of the Club who is a member of that Association for the consideration of the committee.

The first paper for discussion for to-night is "Ventilation and Heating of Coaches and Sleeping Cars," by Mr. Samuel G. Thompson, Assistant Engineer on the Pennsylvania Railroad. As Mr. Thompson is unable to be present the Secretary will read an abstract of his paper.

The Secretary: Mr. President, it is not necessary, I believe, to read the entire paper. It has been published for two months and I presume the members have received a copy of it.

I would like to say in the first place that the question of ventilating and heating passenger equipment cars is one that will be considered at the coming convention of the Master Car Builders' Association at Atlantic City in June. Mr. Thompson, the author of this paper, is Chairman of the Committee having the subject in charge,

and he presents this paper in the hope that a thorough discussion by the Western Railway Club will bring forth information which would not otherwise be obtainable.

The Secretary presented an abstract, the paper in full being as follows:

VENTILATION AND HEATING OF COACHES AND SLEEPING CARS.

By Mr. Sam'l G. Thompson, Asst. Engr. M. P., Penn. R. R.

Gentlemen of the Western Railway Club:

In order to introduce before you the subject of ventilation and heating of coaches and sleeping cars, and to open the matter for discussion on the various points involved, I beg to submit a description of the indirect system of heating and ventilating passenger coaches as used on the Pennsylvania Railroad, giving preliminary to the description, a brief outline of the several earlier types of ventilating systems which preceded and led up to the one now in use.

Although the Pennsylvania Railroad system of ventilation may not be better than many others, it is nevertheless representative of the latest developments and will serve the purpose of bringing before you for discussion the various problems involved. This system of ventilation has been developed by Dr. Chas. B. Dudley, Chemist, assisted by A. S. Vogt, Mechanical Engineer, and others members of the Mechanical Department of the Pennsylvania Railroad. Dr. Dudley has made a careful study of the theoretical principles of ventilation and of their practical application to passenger car service, and it is to him that I am principally indebteed for the information given herein.

As this subject has to do with the ventilating and heating of a car, let us get clearly before us the relation of these two problems. Ventilating does not mean heating, and vice versa. By ventilation we mean a proper change of air without particular reference to its temperature, while the heating of a car refers to the method used to heat the air, either before it comes into the car or after it is in. Whether the two processes should act independently or together is one of the problems. So let us then begin by applying these ideas of heating and ventilation to the earlier types and follow the progress that has been made.

Forty or more years ago we had some studies by Prof. W. Ripley Nichols of the Massachusetts Institute of Technology, in which he investigated a system in use at that time known as the "Winchell Ventilating System." A car fitted up with this system was arranged to take the air in at the end under the front hood, allowing it to distribute as it would throughout the car, and to pass out under the rear hood, without any attempt to warm it. Prof. Nichols was determined that about 7,000 to 10,000 cubic feet of air per car per hour was furnished under favorable conditions. Later experiments with this same

system at Altoona indicated that 15,000 to 25,000 cubic feet per car per hour were furnished, depending on conditions. It was also found that there was almost no air movement in the car when standing still, even less than in any of our modern railway coaches.

The next type of ventilating system was that found in our old-fashioned passenger coaches, known as the "Spear Stove System." It consisted of hoods or intakes at diagonally opposite corners of the car, which intakes were connected with the coal stove. The movement of the car forced the air down around the stove and into a boxing running the length of the car along each side above the floor. From this boxing or duct the warmed air was admitted into the car through various openings in the side of the duct. It then passed upward and went out through the deck sash. This system was a great improvement over any that had been tried, but it still had several defects, as follows:

1st. The current of warm air was reversed and went from the car out through the intakes when the car was standing still.

2nd. The proportion of intakes and exits was not such as to give a balance, and the exits were so much in excess of the intakes that air was admitted through every crevice in the winter time.

3rd. The trailing deck sash gave rise to various cross-currents, which in turn interfered with the proper burning of the lamps, since it was often found that the air would come in the deck sash instead of going out as it should.

4th. The deck sash admitted cinders and smoke overhead to such an extent as to be very annoying, since the construction had not been brought to the higher state of efficiency in which we find the deck sash in use today.

This system was modified later by removing the stove and substituting a steam radiator pipe extending the length of the car in the heat duct and by adding ventilators on the upper deck of the car roof. This was an improvement in that it eliminated the stove and gave an exit for the air other than the deck sash. With some slight modifications this was the type of ventilating system that immediately preceded the one now in use.

The Pullman deck sash system, which has beeen in use for a long time, was evolved from various former arrangements of deck sash, and has been so improved as to eliminate many of the objectionable features of former arrangements. This method of ventilation does not warm the air before it comes into the car and provides no intakes except the deck sash. The heating of the air is done after it has come into the car, and the change of air in the car is principally limited to the amount that can be supplied by leakings and can be taken into and out of the car through the deck sash. In the winter time when the deck sash are thrown open, it very quickly relieves an overheated car, as the cold entering air drops gradually into the body of the car to take the place of the heated air which passes out through the lamp ventilators and deck sash. This dropping of the

cold air is effective, and its mingling and diffusing with the warm air as it descends does not make it objectionable to the passengers; but in the summer time this action is not so pronounced and the movement of air hardly sufficient for good ventilation.

With this preliminary description of some of the earlier systems of ventilation, we pass to the system used on the Pennsylvania Railroad.

DEVELOPMENT AND DESCRIPTION OF THE SYSTEM AS USED BY THE PENNSYLVANIA RAILROAD.

The passenger car ventilating system as used for the day coaches of the Pennsylvania Railroad was started in its development about ten years ago, and is the result of a number of years' study and experimental work.

A large number of experiments and tests were made which led to modifications and changes, each change being followed by runs on the road and by analyses of air taken from the cars under various conditions. This system has been gradually applied to cars since the development period, and is now in service on more than 1,000 cars.

This system is arranged to admit air at hoods on opposite corners of the car roof. The air then passes down a vertical boxing to a horizontal duct under the floor, which runs the length of the car between the side and the adjacent intermediate sills; then the air ascends through slots in the floor to a box or duct containing steam pipes located immediately over the air duct; thence through galvanized iron tubular pipes under each seat to the aisle, where it ascends and passes out through the globe ventilators located along the center line of the upper deck.

The system is designed to furnish 1,000 cubic feet of fresh air per hour per person while working normally on a moving train; this means 60,000 cubic feet per car per hour and a complete change of the air in the car fifteen times per hour, or once every four minutes. That this amount of air is furnished by the system has been proven by numerous tests which were made during its development. Samples of air were taken under various conditions from cars filled with men, while the train was running at speed with all the ventilators open, and while running with all ventilators closed, as well as while standing with all the ventilators open. The analyses were made to determine the carbonic acid in the air, and the calculations made by determining the amount of fresh air that it would take to dilute the amount of carbonic acid exhaled by the number of men in the car, so that the air in the car would equal in carbonic acid the amount that was found to exist in the samples taken. A representative test made in the winter under normal conditions showed by this method that 62,400 cubic feet of air per car per hour was furnished while the train was running about thirty miles per hour with all the ventilators open. 27,000 to 37,000 cubic feet were furnished while running with

all the ventilators closed, and about 23,000 cubic feet while the train was standing still with the ventilators open.

A description of the essential parts of the system is as follows:

The intake hood, vertical and horizontal air ducts, and the heating ducts and pipes form an independent system on each side of the car, which can be operated separately or together. The intake hoods are located at the opposite corners of the car on the roof, close to the upper deck, where they will catch the least amount of dust, cinders, etc. Their openings are covered by fine wire gauze to exclude cinders. The hood contains a flap valve so arranged that the air has a free passage into the downtake from the direction the car is moving. This flap valve is set for the proper direction by the trainmen and is operated from the inside of the car, as is also a butterfly valve located in the downtake, and which is used to exclude foul air and smoke whenever necessary, as for instance, when going through tunnels.

The air passage or duct between the floors and sills of the car is made by removing the cross bracing in the wooden cars and substituting iron braces in the form of a trough section, which braces are bolted to the sills and act as effectively as the wooden ones. This duct must be cleaned occasionally by removing portions of the false bottom. The heating duct located immediately over the air duct contains two or more radiator pipes extending the length of the car. The heating surface is sufficient to give one square foot for each 240 cubic feet of air per hour when the system is operating normally with 60,000 cubic feet of air passing through the car. Steam is received at the middle of the car, passes to the ends, and the condensation is returned to the middle where it is trapped to the track. The heating duct is connected with the air duct by slots in the floor 2″ x 12″. There is one of these slots between each two seats, which arrangement divides the air current as it passes over the heat pipes to a galvanized iron pipe 8″ or 10″ in diameter leading to the aisle under each seat.

There are seven globe ventilators arranged along the center line of the upper deck, five of them over the lamps and one at each end of the car. The two end ventilators have a register in them, the apertures of which when open wide are a little more than equal to the area of the 6″ ventilator tube. The closing of these end registers shuts off all exit of air through these end ventilators. The five combination ventilators over the lamps consist of a register arranged around a smoke bell and tube 3″ in diameter extending upwardly into the ventilator. The registers surrounding the smoke bells are operated the same as in the two end ventilators, while the smoke bells and tubes provide constant openings through the roof equal to about one-fourth of the area of the ventilators over the lamps.

The deck sash in the car are tight and immovable, which restricts the exit of air entirely to the globe ventilators, where the proper proportion of opening is maintained.

OPERATION AND DEVELOPMENT OF THE SYSTEM.

The speed of the train or the wind forces the air into the hoods on the top of the car and down the vertical intake boxing to the air duct, where it is divided as it passes through the slotted openings in the floor to the heat duct. It is again divided as it circulates around the heating pipes, and passes in opposite directions to the galvanized pipes leading to the aisle under each seat.

In the early experimental stage, a continuous slot was cut in the car floor between the two ducts, making practically one duct. This was found to weaken the floor construction of the car, and the air was not held in contact with the pipes the proper length of time to warm it. It was also found that the much better arrangement was to have the cold air come up through the floor at intervals into the heater box and divide and pass each way to the galvanized pipes under the seats which carry it to the aisle. This amount of contact with the radiator pipes having a proper heating surface and sufficient steam pressure was found to satisfactorily warm the car in severe weather with the system acting normally.

The best place to admit the warmed air to the car seemed to be at the aisle under each seat by means of the galvanized tubular pipes which occupy most of the space under the seats, and which in addition act as foot-warmers in severe weather.

Other means of admitting the warmed air into the car were tried, one by allowing the heat to pass into the car between the seats from registers in the side of the heating boxes, but this was found to be objectionable to the passenger sitting next to the window.

Another experiment was also tried with the idea of having the warm air come out through the top of the heater duct and pass up directly along the windows to neutralize their chilling effect, but it was found that these apertures in the top of the box were receptacles for dirt and that the heat currents were objectionable to the passengers.

Various other arrangements of admitting air to the heater boxing and from it to the car were tried, but none of them were as satisfactory as the one finally adopted.

The globe ventilator arrangement was developed by frequent experiments. Cars were fitted up with a large number of ventilators, and also with comparatively few. With twenty ventilators on the car it was found that the front ventilators made more vacuum in the car than could be supplied by the regular intakes, and that air came down through the rear ventilators, thus causing the back end of the car to become cold. This difference of temperature at the two ends of the car was eliminated by closing some of the ventilators, which seemed to prove that the intakes and exits in any system should be very nearly equal in order to obtain the best results. Some cars were fitted up with seven ventilators, as is the present practice, but having all the ventilators of the end type, having a register with apertures about equal to the 6″ ventilator tube and not having the

smoke bell. These large ventilators were placed between the lamps and were in addition to the lamp ventilators, but it was found that with six ventilators of the end type and the five lamp ventilators, more air was taken through the car than could be properly warmed in severe weather. This led to the partial closing of the lamp ventilators, so that 2″ were left for the escape of the lamp gases. It was soon found that the lamp gases were such an important element in the problem that they would have to be taken care of in some better way, as the 2″ opening resulted in the smoking of the head-lining. A combination globe ventilator with a 3″ smoke bell was designed, and one was placed over each of the five lamps. These five combination ventilators with the two end ventilators were found to be about correct to give the system the proper balance and the required flexibility. When the train is running, the air is forced into the cars at a slight pressure and the area of the ventilators when all wide open in their normal position is such as very nearly to maintain a balance of pressure inside and outside the car, and at the same time to allow the proper amount of fresh air to pass through the car. The ventilating registers, however, may be partly or altogether closed, in order to restrict below normal the amount of air to the requirements of very severe weather. This partial closing of the ventilators increases the pressure inside the car and still further diminishes the draughts that enter around the windows and doors. It retains the heat in the car without seriously restricting the air movement, as there is still a considerable exit for air through the smoke bells in the lamps ventilators. This restriction of air movement can be used to give the best of ventilation in cold weather when there are few passengers in a car, in which case the necessary change of air is much less than when the car is crowded. This results in a considerable saving of steam.

As the deck sash in this ventilating system are tight and immovable, the amount of outgoing air is dependent upon and regulated by the ventilators. The closing of the deck sash is an essential feature and is necessary for the proper movement of the air currents and for the balancing of the pressure inside and outside of the car. This closing of the deck sash also prevents cinders and dirt from coming into the car overhead. As the normal movement and the amount of air currents passing through the car are regulated by the opening of the globe ventilators and pressure at the intake, it is obvious that any opening of the deck sash, and the windows and doors as well, will destroy the normal working and set up various cross-currents.

The system is not entirely dependent on the movement of the car, since when the car is standing still the normal circulation of air is maintained by the rising heated currents when there is heat or light in the car. This natural rising of the warm currents will furnish about one-third to one-half of the change of air necessary for a crowded car. When there is neither heat nor light in the car, which is usually in the summer time, the proper ventilation is not furnished by the system proper when the car is standing, but is obtained by opening the windows and doors.

The amount of the change of air passing through the car when running at speed is somewhat dependent upon the speed and the direction of the winds, and the apparatus should be regulated accordingly by the trainmen. The two independent sides of the system depend for their relative efficiency on the direction of the wind. If the wind is dead ahead, both sides seem to be equally effective, but with the wind ahead or to the right or left, the side from which the wind is coming seems to do the most ventilating. When the train is running with the wind, neither side works quite as efficiently as under the conditions aforesaid. With the car closed in the winter time, the temperature and movement or air in different parts of the car are almost uniform, and the currents of air hardly active enough to be perceptible. Globe ventilators are used on the roof over the closets at each end of the car, which, in connection with the close balance between a plenum and vacuum in the car, tend to show a slight motion of air current toward the closets rather than from them.

As a whole, the system is very efficient in almost every way when the train is running, but when it is standing still, the system does not provide for any better ventilation than is afforded by the ordinary open deck-sash arrangement. This can be clearly seen in a smoking car by observing the accumulation of smoke and the stillness of the air when the car is standing at the station awaiting departure with the doors open; and then by watching, with the doors closed, the gradual disappearance of the heavily ladened air until the train has attained its speed, at which time the air in the car has become fresh and the car almost cleared of smoke. The smoke passes from all parts of the car very gradually and without showing the presence of cross-currents or draughts, and fresh air is supplied without attracting the attention of the passengers. The circulation and distribution of the air in the car seems to act in the same general way when the train is standing still as when running, except that when standing, the air movement is slight and dependent upon the difference of temperature inside and outside the car; while, in the latter case, this difference of temperature is augmented by the forcing in of the air at the intake and by the induced draft at the ventilators. In the one case the change of air is not sufficient for good ventilation, while in the other the proportions seem to be about correct and most of the difficulties of the problem solved in a practical and simple way. The conditions prevailing while the train is standing still are so quickly relieved after it gets into motion that the lesser amount of ventilation supplied in the former case is comparatively of minor importance; which means that, in any system of passenger car ventilation, we have first to consider the conditions in which the passengers are kept enclosed for hours at a time during the trip, and then to take care of the minor local conditions as best we can in accordance with the necessity.

The following are a few questions which suggest themselves and which might be considered in conection with the above systems and with the various other systems of car ventilation and heating.

1. Is it possible to have a passenger car ventilating system separated from the heating system, or, in other words, should the air be heated after it is in the car, by radiators or by other direct means of heating, or should the indirect method be used in heating the air before it is introduced?

2. Can the down-draught system as used in buildings be applied satisfactorily to passenger cars, by admiting warm air overhead to be gradually distributed through the car as it gradually drops to the breathing line, and then to be exhausted from the car at the floor?

3. Do we need a forced draught system such as might be constructed by fans and motors, and are the defects of our present systems sufficient to warrant this extra expense in any of our passenger services?

4. Would it be an advantage from a ventilating standpoint to have the car windows arranged to open by dropping instead of by raising, this arrangement to be used in steel cars where it might be possible to provide sufficient clearance in the car side for the dropping windows?

5. Could a spring-balanced or counterbalanced window be applied to a sleeping car, so that it could be raised or lowered in the summer time by the occupant of the berth, and would this be a practicable method of bettering the ventilation in our sleeping cars in the summer time?

6. Could an indirect system of heating and ventilation be applied to a sleeping car so that a system of regular or auxiliary registers leading to each berth could be opened and operated by the occupant of the berth?

7. Is it necessary to have an elaborate ventilating system in our light suburban steam or electric trains, or would the ordinary deck-sash system be sufficient for these short-trip cars, which are thrown open for the exit and entrance of passengers at frequent intervals?

8. How much air should go into and out of a car to furnish good ventilation, in an hour, and is there any better method to determine such amount than by a test for carbonic acid of samples of air taken from a car under various conditions?

9. For a system of indirect car heating, what is the best method for introducing the warmed air into a passenger coach, chair car and sleeping car, and at what point should it be admitted?

10. For a system of indirect car heating, what is the best method for heating the necessary amount of air in the limited amount of space available?

THE SECRETARY: I have two or three communications, Mr. President, in regard to this matter; shall I read them now?

THE PRESIDENT: We will listen to the communications.

MR. B. P. FLORY (M. E.—C. R. R. of N. J.): The question of heating and ventilating passenger cars is one of the most annoying

things a railroad has to contend with. Each passenger seems to want a different degree of heat and a different amount of fresh air from another.

It is manifestly impossible to have a system that will suit everybody, but I believe that we should have the best system that there is.

The system in use on the Pennsylvania Railroad, of which Mr. Thompson has given us a description, has some advantages over others. These advantages are heating the air before it passes into the car body proper, and discharging the air at a point where it does not come into direct contact with the passengers.

The disadvantages of this system are that, possibly, by heating the air first, some of the oxygen is taken out of it which tends to create a stuffy atmosphere in the car, and that, as the air rises from the floor line, it is liable to carry dust and germs with it.

On the Central Railroad of New Jersey, we are using a system which, though not brought out by this road, has been in operation for about five years, and the developments in the system have been brought about by our experience in connection with the Ventilator Company.

These ventilators go in the place of the regular deck sash, and are constructed as follows: In the middle of the panel on the outside is a deflector, perpendicular to the side of the car, which is bent on the end so as to deflect the air into the forward opening of a box about 4 in. by 6 in. in size which extends from the outer panel to the inside of the car. A similar opening is behind the deflector; this opening acts as an exhauster. The amount of air to be taken in, or exhausted, is regulated by shutters attached to the inside panel. The centres of these openings are about 10 in.

For a 60 ft. passenger coach, seating 75 passengers, there are 7 sets of these ventilators on each side of the car.

For a combination smoking car, seating 50 passengers, there are 6 sets on each side of the car.

The amount of air taken into the car depends on what speed the train is running. It is usually about 100 cubic feet per minute, per set of ventilators, at 40 M. P. H. The amount of aid exhausted is about 116 cubic feet per minute, per set of ventilators, or a little more than the intake at the same speed. This excess is caused by the discharge of air which comes in around windows and doors. With our cars having 14 sets of ventilators we get 1,400 cubic feet of fresh air per minute, or 84,000 cubic feet per hour, or 1,150 cubic feet of air, per hour, per passenger.

From experiments made to determine the direction of the air currents, it was found that they went a little forward of the opening to the centre of the car before descending, thus preventing a draft on the heads of the passengers.

Some experiments in temperatures of the entering and intake air

have been made. On one local run of 25 miles the temperature of the air intake was 38° and of the discharge 71° throughout the entire run. On another run of 100 miles the temperature of the intake air was 38°. exhaust 64° and of the car 68°.

On account of the construction of the deflector the cinders striking it drop down, and it has been our experience that very few enter the car.

Some trouble we experienced at first in respect to rain coming in through the openings during a rainstorm. This was remedied by having the air duct drop from the inside to the outside of the car about ¾ of an inch.

The ventilator shutters are not very artistic looking, and, when it is desired to make the interior of the car look alike as regards the deck sash they can be put in all along the car, and where the automatic ventilators come the shutters are attached to the deck sash, and opening the deck sash opens the ventilators.

This same scheme of ventilation can be used in the car windows in place of the regular screen. In this case, a panel with the two ventilators is used in place of the regular window screen, and is very convenient to use when travelling in a sleeping car, as it gives the passenger absolute control over the amount of air he desires and admits no cinders.

Mr. W. H. Wilson (S. M. P., B. R. & P. Ry.): I would answer the question referred to on the last page of the paper, as follows:

No. 1. I believe it is possible to have a passenger car ventilating system separate from the heating system. I believe the air should be heated after it is in the car, by radiator or other direct means of heating. I do not believe the indirect method used in heating the air before it is introduced is satisfactory.

No. 2. I do not believe the down-draught system, as used in buildings, can be successfully applied to passenger cars.

No. 3. I do not believe that a draught forced by fans or motors is required for the ordinary and general passenger service. The defects in our present systems are not sufficient to warrant the expense of installation and maintenance, in view of the benefits derived.

No. 4. I believe it would be an advantage, from the stand point of ventilation, to have car windows arranged to open by dropping instead of by raising, provided the constructions of the car would permit of that arrangement.

No. 5. I believe it is possible to construct a counterbalanced window for sleeping cars, of a design that will permit its operation by occupant of berth, provided a satisfactory screen could be attached to the sash or made to work with it and insure the protection of the opening made by the window. It would be extremely hazardous to

have open windows in sleeping cars not protected by fine mesh screens.

No. 6. I do not believe that a satisfactory system of indirect heating and ventilating can be applied to sleeping cars, with registers to be operated by occupants of each berth.

No. 7. I am not sufficiently familiar with light suburban steam and electric trains to express an opinion of any value, but it would appear, from the frequent opening of the cars to permit passengers to get on and off and the short trips made by such equipment, that no elaborate ventilating system would be necessary.

No. 8. So much depends on the size of car, class of service and number of passengers that a fairly intelligent answer to question number 8 can hardly be made. I am not familiar with any satisfactory method of determining the amount of air that should go into and out of a car to furnish good ventilation that will cover all classes and conditions of service.

No. 9. I believe the best method of introducing warm air into a passenger coach and sleeping car when the indirect system of car heating is used is underneath and along the entire length of the seats. For chair cars along the side of the car next the floor.

No. 10. I believe the best method of heating a required amount of air in the usual limited space available in passenger equipment cars, having the indirect system of heating, is to pass the air through and around a sufficient area of steam piping closely arranged.

Mr. W. L. Kellogg (M. M., Pere Marquette R. R.): I have your letter of January 8th, and paper on ventilating and heating of coaches and sleeping cars, and give you my reply to the ten questions on last page of paper referred to. I am sorry not to be able to be present at the meeting, but hope that my reply to the questions will be of some benefit.

1. It is possible to have the ventilating system separate from the heating system, but think the indirect method of heating the air before introducing it in the car would be more satisfactory.

2. Do not think the down draft system could be successfully carried out in passenger car heating and ventilating.

3. Forced draft would be too expensive and liable to get out of order, and do not think any better service could be obtained.

4. Do not think it would be a benefit to have car windows to drop instead of raise.

5. A spring balanced or counterbalanced window could be applied, and think it would prove most satisfactory.

6. An indirect system of heating and ventilation could be applied to sleeping car with separate register in each berth to be operated by occupant, and think this would be satisfactory.

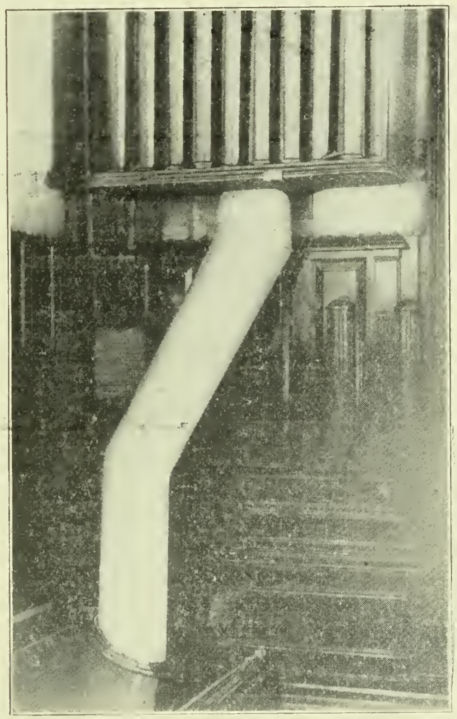
7. It is not necessary to have an elaborate ventilating system in suburban cars inasmuch as they are opened very frequently.

8. Do not have any idea how much air should go into or out of a car to furnish good ventilation, but do not know of any better method of determining such amount than by testing for carbonic acid samples of air taken from the cars under various conditions.

9. Think that the best place for introducing warmed air into passenger cars would be under the seats, and for chair cars along wall under windows, and sleeping cars in either end of berths.

10. Think the best method of heating air would be by steam pipes placed under the floor between the sills of car.

Mr. C. A. Schroyer (C. & N. W. Ry.): On the Chicago & Northwestern Railway we used for a great many years the Spear heater in connection with the heating stove and ventilating apparatus, which briefly consisted of a pipe in which the regular stove



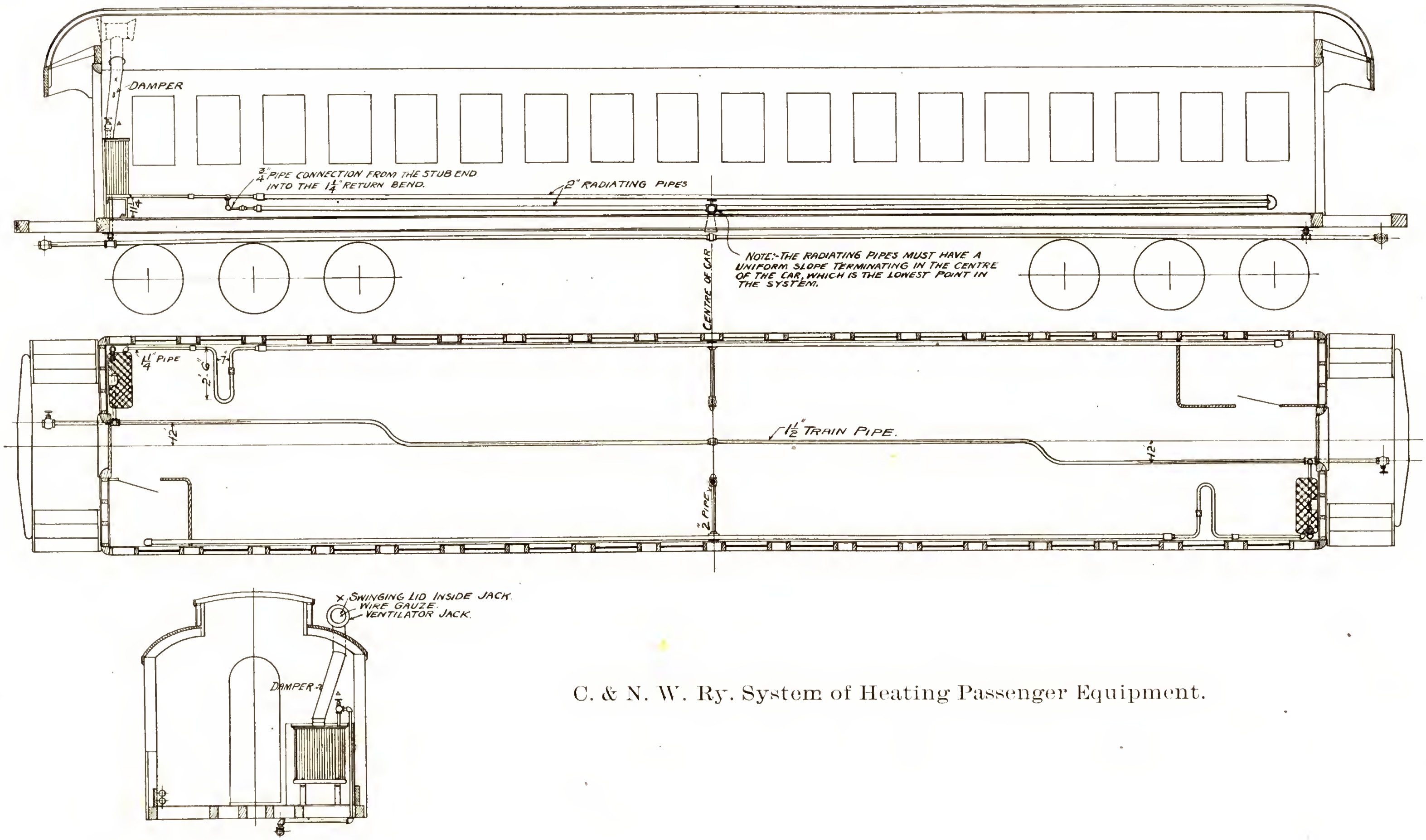
C. & N. W. Ry.

pipe was encased, with a jack on the outside of the car approximately 12 inches in diameter at the opening and the stove pipe extending up through its top portion, both ends of the jack being arranged with an automatic damper, which would open and close according

to the direction in which the car was moving. Air was admitted through this jack and by the speed of the car forced down around the jacketing of the stove, which had a space of about 3 inches all the way around the fire pot, where the air was heated as it passed downward and into the distribution boxes along the truss plank underneath the seats of the car.

We found that this system of ventilation and heating was equal to anything that had up to that time been introduced for this purpose. It had some disadvantages because of the contracted area of the openings and the liability of the same to be clogged up with dust and cinders, which effectually prevented the ventilating feature of the apparatus.

This system of ventilating and heating was largely in use on the ordinary coach equipment up to the time the steam heating devices were introduced. Where Baker heaters were used in our cars there never was any special effort made to introduce any ventilating system except that which was provided by the upper deck sash. By the introduction of steam heating in our passenger car equipment we applied therewith a ventilating system, which is shown on illustration herewith. These illustrations show the interior of the end of the car where the ventilator and radiator are located, and I would be glad to have them inserted in the proceedings of this club as illustrating what the Chcicago & Northwestern Railway Company is doing in the matter of ventilating coach equipment. This, you will observe, embodies the principal features of the old Spear stove and ventilator. The jack is located on the roof of the car, at diagonal corners on the lower deck. By either the forward or backward movement of the car fresh air is scooped in through this jack and is forced downward through the pipe and distributed through the open end of same into the body of the radiator. Under the motion of the car there is sufficient velocity to the air in its downward movement through this pipe to reach the floor line of the car and by passing through the heating pipes of the radiator it is heated to such an extent that in its distribution but little variation in temperature exists at the front end of the car over what it is at the center of the car. This radiator contains approximately 100 feet of radiating surface, and is located inside the end doors for the purpose of quickly radiating the heat at that point to counteract to the greatest possible extent such blasts of cold air as are ordinarily admitted into the car by the opening of the end doors. This apparatus, as is the case with many others, does its best work under the speed of the train. It has but little, if any, value as a ventilating system while the car is standing still, but under speed very marked benefits are noticeable by the movement of the air, especially so in smoking cars, where this movement of the air is visible by the smoke therein, and while we are not able to state as to just what volume of air is



C. & N. W. Ry. System of Heating Passenger Equipment.

scooped into the car, the amount varies with the speed and it is sufficient to keep the atmosphere of the car clean and sweet.

The principal points of merit in a device of this kind is in the fact that the air is scooped into the car at a point where the cleanest air can be obtained, and while it is true that the trailing of the smoke directly over the train does in a measure cause some of it to be admitted into the car, it rarely trails so low as to form a feature objectionable to the system.

In the heating apparatus of the car you will observe that the supply pipe is located underneath the car, the highest point being in the center of the car and the lowest point being near the end at the inlet into the car. The hose used is the Gold, with traps in the couplings so arranged as to discharge any condensation which may accumulate in this pipe, hence it is unnecessary at any time to uncouple the cars while they are standing cold, it being our practice to allow our cars to stand cold at the terminal points. The inlet valve admitting the steam into the heating system of the car is located at the highest point on the heating system that water of condensation may flow both directions from it and thus avoid any tendency to freeze up. The lowest point on the heating system of the car is the floor valve, and you will observe herein that there is no automatic trap used, it being a tight valve, with the 2 inch heating pipe extending all the way to the valve. It has large ports for the purpose of preventing freezing by the small amount of drippage occasioned after the car has been cut off from its steam supply. There can be no freezing of the system until the inside of the car becomes sufficiently cold for so doing. In the operation of the same the steam is turned on at the inlet valve over the radiator, the floor valve being allowed to remain open until the live steam discharges and then it is closed and remains closed until opened occasionally by the brakeman for the discharge of the water of condensation, it being intended that the water of condensation should be held in the pipe a sufficient length of time to obtain therefrom such amount of heat as is practicable under the varying weather conditions. Both sides of the car work independently of each other, so that in ordinarily mild weather the inlet valve is unseated, allowing a small quantity of steam in whichever side of the car is thought desirable.

No trouble has been occasioned from any freeze-ups in this system, and while it is true that the discharging of the water from the heating pipes must be done by the opening of the floor valve, the brakemen on the line everywhere, on approaching terminals, have a certain point at which all these valves are opened and a signal is given the engineer to shut off steam when they are sufficiently well blown off to prevent freeze-ups.

In our special car equipment, which are heated by means of Baker heaters having steam attachments, traps are used for carrying off

the water of condensation as fast as it may accumulate, because of the necessity of greater amounts of heat coming into contact with the water circulating system of the car.

We have not succeeded in finding anything that would ventilate this class of equipment any better than does the ordinary deck sash, and while it is true that some attention is required to obtain the best results with the use of the deck sash, the results obtained justify such care and attention. In the various patented schemes which have been presented to us from time to time we have always found it necessary to use the upper deck ventilators in connection therewith. Several ventilating devices have been presented to us which comprise a vacuum scheme for pulling the air out of the car. We have not considered them favorably because air cannot be pulled out of a car without admitting a corresponding amount into the car, unless a vacuum is created, and the motion of the car is depended on for producing these results. Where this obtains it is necessary that deck sash be used so as to have the vacuum ventilators do their best work, and as good results can be obtained without them.

There can be no comparable conditions between a car and house or public hall ventilation as the conditions in the car vary every minutes of time they are on the line, both by the curvatures of the lines, the direction of the wind currents and the varying speed of the train. In our passenger coaches, where the greatest necessity obtains, because of the large number of persons carried in each car, for admitting a greater amount of fresh air, we have endeavored to accomplish this by the system we now have in use, and in which we can admit greater or lesser amounts of air by the increasing or decreasing of the size of the jacks and pipes for so doing. Dampers in the pipes we have found to be objectionable and hence have discontinued their use.

Mr. J. E. Simons: A perusal of the paper read by Mr. Thompson before the club indicates that there is still a considerable interest in the subject of heating and ventilating passenger cars. The system of ventilation used by the Pennsylvania R. R., and described by Mr. Thompson, gives very good results under favorable conditions, and we must admit that the cars equipped with this arrangement for ventilating, are, as a rule, very satisfactory, as to the condition of the current of air throughout the car. However, there are so many conditions to meet that it is difficult to even suggest anything better, except at a cost which would not be warranted at this time.

The difficulties apparent are, variation in speed of trains, velocity and direction of the wind, vestibule and non-vestibule cars, humidity of the atmosphere, number of passengers per car, securing a good, clear current of air, variation in temperature of the air, proper means

of heating the air when received, and the variation in temperament of passengers.

All these items must be taken into consideration, and when each one is seriously considered or properly investigated and the proper relation to each other determined, then a proper device may be obtained that would satisfactorily ventilate a car.

My opinion is that it will be found necessary to use forced draft in order to secure an ideal ventilation which can be regulated to suit conditions more readily than any device now in use. Such an arrangement would not be practical while steam is being used as a means of power, but the use of electricity for power will offer much better opportunities on account of its adaptability and easy means of conveyance to the point where it is desired to use it.

The introduction of a drop sash would not be desirable on account of the uncertainty of the conditions already stated. If a proper means of ventilation could be obtained, the most desirable thing to do would be to make the sash stationery, so that it could not be raised or lowered, for by doing this the regulation would not be interfered with by the passenger.

The air should be heated when received into the car, and should be radiated from below or near the floor of the car. This method is not so objectionable, and provides better opportunities to change the air due to the tendency of heated air to rise rather than drop.

A spring balanced window would not be of any particular advantage for use in a sleeping car over the present method of raised sash and screen. However, there is a necessity for some arrangement whereby the air in the lower berth especially could be changed more frequently than it is at the present time. The heavy curtains used are often buttoned so closely that there is very little opportunity for air to escape.

With the use of the electric current in modern cars a small fan would be of service, and could be subject to the desire of the passenger on the same principle as the present berth lights. This would be of great benefit until some good ventilation system can be procured.

In suburban service the necessity for an elaborate ventilating system is not apparent. Many of the passengers do not remove their wraps during the short journey, and the air may be admitted into the car by the most convenient methods that would insure a change of currents to cover requirements. The frequent use of end doors, together with the use of non-vestibule cars insures a frequent change of air. As to the best method of receiving air into the car and heating it this would require more time for thought and study than we have had time to give this subject, and would seem to be of sufficient importance to make it worthy of special consideration by some authorized body.

Mr. G. C. Bishop (S. M. P. Long Island R. R.): I have your letter of January 8th, enclosing a paper on ventilation and heating of coaches in sleeping cars and give you such suggestions as I have to make, in case they may of any value to the Committee.

1. It is my opinion that, when heat is used in passenger cars, the cold air should be heated before it enters the car, and that the ventilating of a car ought to be divided into three separate parts:

a. Ventilating during a period when no heat is on the car and windows are not opened.

b. Ventilating a car when heat is used and the car is standing in the station.

c. Ventilating a car while running over the road with heat being used.

The problem of ventilation in warm weather when windows and doors are kept open, of course can be neglected.

2. It seems to us doubtful if the down-draught system can be satisfactorily applied.

3. Some forced draught system would seem to be the only one that can fulfill all the requirements when a car is standing, and also moving, but we are inclined to believe that the complications incident to the use of such a system would preclude it.

4. We are inclined to believe that the ventilation of a car could be improved by dropping the sash instead of raising same.

5. We are inclined to think that a better balanced window in sleeping cars, which could be arranged so as to be adjustable, would improve the ventilation of the berths.

6. We are doubtful if an indirect system of heating and ventilation can be applied to a sleeping car without a fan blower system or other arrangement, which would make it unduly complicated.

7. It is our opinion that it is not necessary to have an elaborate ventilating system in light suburban trains, and that the ordinary deck sash system will take care of this.

8. We know of no better system than Dr. Dudley has worked out on the test for carbonic acid.

9. We are of the opinion that a desirable place for admitting warm air to a passenger car is near the floor.

10. There has been so little developement in the direction of heating air admitted to a passenger coach, except by direct radiation, that we are not able to give you any satisfactory information in this direction.

The Secretary: Mr. President, these are all the communications I have on that subject.

The President: The matter is now open for discussion from the floor.

Mr. S. P. Bush (Buckeye Steel Castings Co.): I simply want to say a word in regard to Mr. Thompson's paper. I happened to

be connected with the Pennsylvania Railroad at the time they were introducing the present system of ventilation, which he describes. Since then, on one or two occasions I have taken advantage of opportunities I have had to inspect it by riding in their passenger cars. My experience has been that it is very satisfactory indeed. I do not think Mr. Thompson has over-stated the case in the way of results they are getting.

The President: I was very much in hopes we would have Mr. Garland with us tonight, who has experimented along this line. Is Mr. Garland here?

Mr. T. H. Garland (C. B. & Q. Ry.): I did not expect to say anything on this subject, but as the President has called on me I will make a few remarks in regard to some experiments I have made in ventilation.

I started out about three years ago, not to ventilate passenger cars but rather to ventilate refrigerator cars; this was brought about by the fact that all of the roads are paying and have been paying for many years very heavy claims for losses on shipments of perishable freight, due to poor ventilation in refrigerator cars. The amount of these claims runs into thousands of dollars every year with all the roads. In order to find some means of obviating these claims, I looked around to see what kind of a device might be obtained to remove or draw out the hot air and gases that accumulate in refrigerator cars when loaded with fruits and vegetables, and not finding any suitable device on the market, I made an attempt to get up a device that would accomplish this result. Although the experiments have not as yet been very extensive, the tests made so far show that this can be accomplished by a ventilator built on the exhaust principle. I have placed a ventilator of this kind on the top of refrigerator cars in the center and between the doors which at the ordinary speed of about twenty-five or thirty miles an hour of freight trains, will take out all of the hot air and gases or completely change the air in the car every five or six minutes. The results we have obtained from the refrigerator car ventilator led me to believe that similar results might be obtained on passenger cars.

The tests made on the road with which I am connected, show that at the higher rates of speed made by passenger trains, the ventilator will exhaust about 15,000 cubic feet per hour, or with ten ventilators on a car, they will take out something like 150,000 to 200,000 cubic feet per hour, or, exhaust or take out all the air in the car in from one to three minutes. Taking out the impure air, I think is the first thing to be considered. Then the matter of providing an intake comes up, to provide some suitable means of taking in fresh air. The ventilators drawing out such a large amount of air, it is somewhat difficult to obtain enough fresh air through the natural leakage of the car, through the windows and doors. Still,

as the doors are opened so frequently, we have not experienced as much difficulty as one would expect, but I believe we will have to give attention to the matter of intakes as well as to drawing out the foul air.

The ventilation and heating of cars certainly go together, and I believe that they should be considered at the same time. While the heating is only done during the winter months, it is a part of the system, that should be considered with the ventilation of cars.

Among the questions asked by Mr. Thompson is how much air should be supplied to a car to produce good ventilation. Putting it in round numbers, I should say for an ordinary coach that we should have 200,000 cubic feet of air per hour, that is, for a coach seating sixty or seventy people. Each adult requires approximately 3,500 cubic feet of air per hour, and this multiplied by sixty gives the amount of air that should be supplied to a car. By providing suitable intakes which I think can be done without very much expense, I believe that we can work out something practical. We all know that opening the deck sash produces drafts, to which the passengers object, and in making my experiments, starting with the refrigerator car, I have tried to avoid any direct draft into the car that would let in dirt, cinders, etc. I think that with some further experimenting we will be able to get a better system of ventilation and heating than we now have.

Mr. W. E. Symons: This is a very interesting subject and one that should be pretty thoroughly analyzed as far as possible at this particular stage of the art, although I think it is safe to predict that the subject is only fairly begun. This club is very fortunate in having this papr from Mr. Thompson, and in fact, the railway world owes much to the Pennsylvania company for the lines of research, experiments and development, which they have followed not only in this, but in other matters, which have almost invariably resulted in much benefit to railways in general.

I do not feel myself competent to offer definite or conclusive answers to any of the questions propounded, but will comment or offer suggestions in connection with one or two of them.

I am inclined to think that a ventilating system separate from the heating system will eventually be more desirable and successful than a joint arrangement. Valuable information, however, may be obtained in conducting experiments with both types. The down draft system as used in buildings, I am inclined to think, will be more successful in heating cars; this for various reasons; primarily the conditions under which a car is ventilated, and under which a building is ventilated. Buildings, as a rule, remain where they are constructed, while with cars the condition is the reverse, as they are moving within space under varying speeds, and under the present

system of ventilation it is the speed which controls such ventilation as is secured.

Again buildings, as a rule, have the heating plants in the basement, which has a tendency to warm the entire building above the location of the heating plant; therefore, the occupants suffer no inconvenience from cold floors, while with coaches if the heat were applied at any point above the floor, the floors would remain cold resulting in discomfort to passengers and in many cases causing physical ailments resulting from cold feet, while the upper portion of the body was in the hot air zone.

The next question of importance is that of forced draft with respect to which a communication from the officer of one of the Eastern lines has been read, wherein he expresses an unfavorable opinion based on the expense, and insofar, as this may be considered in connection with day coaches on local or branch line trains I would agree with him, but in the consideration of the ventilating of Pullman or sleeping cars, which is the all absorbing and most important question, I would certainly disagree. The question of expense should not stand in the way of providing all occupants of sleeping cars with the full amount of fresh air which nature intends a person should have at all times, and a glance at the latest published annual report of the Pullman Company wherein it is shown that a profit of something over $20,000,000 was made last year, would indicate that the properly equipping of their cars with some effective ventilating system would not cause them any financial embarrassment. It is a notorious fact, that the so called "ventilating systems" of sleeping cars may be regarded as relics of barbarism. Travelers go to hotels and if placed in a room with less than one thousand cubic feet of space and not well ventilated they will be dissatisfied, and not infrequently would leave the hotel in anger, seeking a more desirable place, but when ready to travel by railway train, they allow themselves to put in a space of sixty-two cubic feet without any ventilation at all, except at times during the summer when a screen is applied, and during the time they occupy this berth the air becomes so thoroughly poisoned with carbonic acid gas from the result of re-breathing, that in a majority of instances, a person will experience a dull headache from the ill effects of being robbed of what nature intended one should have, while riding in what we sometimes term a "luxuriously appointed car." I hold that it is within the range of possibilities, that it would not impose any unreasonable financial burdens, and it is right and proper that sleeping cars should be thoroughly ventilated, and that both the heating and ventilating arrangement should be of such a character that the occupant of each section would be in position to control the same in the berth or space so occupied.

A noted public sepaker in commenting on the necessity of an am-

ple supply of fresh air at all times, mentioned the fact, that "this was one of nature's gifts to man, which up to date had not been gobbled up by any of the existing trusts, and was, therefore, to be had without money and without price."

In the matter of car windows dropping, I am inclined to think this should be governed by future designs of cars. As a general proposition with the present design of car, I am inclined to think unfavorably of it. The spring balance principle is operated to a very good advantage, and it would seem that this could be extended with very good results, although the price would probably render it undesirable for coaches of older types that are on unimportant runs.

Any elaborate system of ventilating on suburban or electric cars where the doors are frequently open for passengers to enter or leave the cars I think would be an unnecessary expense, and if enforced by law, it would impose unnecessary hardship on the carriers.

As to the amount of air that should enter a car in any given time that, of course, is governed by conditions, as has been said by a previous speaker, "An adult person in normal condition and at twenty respirations per minute, will breathe about 3,500 cubic feet of air per hour;" an adult person should ordinarily sleep in a room with not less than a thousand cubic feet of space; the room to be well ventilated by a transom and at least one window, causing a current of air to pass through. If from any cause a person should sleep in a room not ventilated, it should contain not less than three thousand cubic feet of space, and even with this amount of space, the air will become charged with carbonic acid gas or carbondioxide in about eight hours, so that it becomes unhealthful. The effects of this being manifest by a feeling of drowsiness to a headache or a deep coma, which is detrimental to, and affects one's mental faculties in proportion to the amount of poison and their ability to throw it off.

With your permission I would like to quote a circular recently issued by the Health Department of the City of Chicago:

AIR IN CARS LIKE THAT IN SEWERS.

Health Department Has Pamphlet Urging Need of Ventilation.

Passengers in street cars were urged to insist that the conductors properly ventilate the cars, in a pamphlet issued by the health department today. The pamphlet sets out that the air in many of the cars is worse than that in the sewers and that the fault lies not with the companies but with the passengers.

"Some years ago," reads the pamphlet, "a gentleman in Boston made tests of the air in the street cars of that city and found that it contained 23.3 parts of carbonic acid to 10,000 parts of air. Normal air contains four parts of carbonic acid in 10,000. At the same time, tests made of the air in the Berkeley street sewer of that city showed only 10.4 parts of carbonic acid per 10,000.

"A man crawling through the sewer would be no worse off, as far as his fresh air supply was concerned, than his fellow who paid his nickel and

patronized the street cars. It is an easy matter to ventilate the street cars but not so easy to ventilate the sewers.

"Passengers in street cars can have fresh air for the asking. Better shiver a little and have good air to breathe than to swelter in comfort that means sickness, suffering and death. In these days of trusts and combines, it is sometimes said that air is about the only thing that has not been cornered. See to it that you get your share."

The lesson to be drawn from the information given in this newspaper clipping should serve us well in considering the question of ventilating sleeping cars, for when conditions, such as described, exist on a street car where the doors are frequently opened to allow passengers to enter and go out, the conditions are much worse on a sleeping car that is closed for many hours at a time in making trips between important cities in our country; many of them going over two thousand miles between terminals.

Some years ago while in Savannah, Ga., my business called me to New York very often, and in making this trip, I would take a sleeping car at Savannah, which was assigned to run between New York City and the lower portion of Florida. Frequently the passenger travel was light, sometimes there being not more than a half dozen passengers. The trains from Washington City north were Pennsylvania equipment, except these Pullman cars from the south, and it was my custom to invariably go in the Pennsylvania coach ahead of the Pullman car, in order to get fresh air to breathe. These cars being fitted, as I understand, with the ventilating device described here tonight, and the working of which has been endorsed by Mr. Bush, and although these coaches were frequently filled with passengers to the entire seating capacity, yet even under these conditions the circulation of air through them was so perfect that the change in going from a stuffy Pullman car into a coach was almost as marked as passing from a close stuffy room out doors into the open atmosphere, which proves that cars can be ventilated, if their owners will simply exert themselves in that direction.

This, gentlemen, is a live question, and just so long as we allow ourselves to be mistreated with respect to the matter of ventilation, just so long we will suffer the ill effects coming therefrom.

We have no right to mistreat ourselves, or allow others to mistreat us in a matter of this kind. We should see to it, that in sleeping cars and coaches, we are provided with all of the fresh air that is necessary or essential to the preservation of a good healthful condition, and when this is accomplished, it is reasonable to assume that the present death rate from certain ailments, the cause of which may be traced to breathing poisonous, or unhealthful air, will be reduced, rather than increased.

The President: One of our Western roads that has very high and very wide directors has improved the size of their sleeping car berths, and I would like to know if the sleeping cars on the Chicago,

Milwaukee & St. Paul Railway are provided with any better ventilation than the Pullman cars that have not these dimensions?

MR. A. E. MANCHESTER (C. M. & St. P. Ry.): We are glad to have the President of the Western Railway Club give us free advertising on the height, length and breadth of the sleeping car berths on the Chicago, Milwaukee & St. Paul Railway. As to the ventilation, I do not know that we have hit any marked improvement over what is done by the Pullmans. We tried to give a few more feet of cubic space to poor humanity who is preparing tombstones for itself while riding in the sleeping car.

The ventilation of any car is not an easy proposition and, while, as railroad people, we have no right to sit down and say that the people are well enough satisfied with what they are getting, from the fact that they patronize the railroad trains and they patronize the sleeping cars, yet, I feel very much in doubt whether anything has been brought forward that is felt generally to be satisfactory and to fill the want as expressed by some of the speakers. It seems one of the greatest difficulties that has been experienced thus far is the different requirements of the different people. One wants to live in a high temperature and the other in a low temperature and they have got to be such close neighbors in a car that it is almost an impossibility to give them what they both want. I remember reading a little "squib" not long since. A gentleman had been unfortunate enough to get an upper berth, and he was not altogether pleased with his place in the world; he went to bed feeling a little bit out of humor and had just got straightened out and ready to go to sleep when the man in the lower berth opposite to him rang the porter up and said, "Porter, for Heaven's sake, open that window: I'm dying." About the same time a lady in the next lower berth said, "Porter, close up that window, you are freezing me to death; you will kill us if you don't stop this." The gentleman in the upper said, "For Heaven's sake, open the window a little while and kill one and then close it and kill the other, and let the rest of us go to sleep." (Laughter.)

C. H. BALL (Chief Sanitary Inspector, Department of Health): Mr. President and gentlemen, I owe my presence here and the opportunity of listening to your interesting discussion to your kind invitation to Dr. Evans, who found it impossible to attend this evening. I have read the paper of Mr. Thompson with great interest and it seems to me that you have a very profitable subject for discussion.

The old method of transportation, like many other of the old methods which we have outgrown with the advance of civilization did not offer the dangers and problems which we find in our newer methods. There is a tale current among the sanitariums, however, of the prairie schooner, the occupants of which started from one East-

ern state, traveled to the Pacific coast and when the family reached some convenient halfway state, I think it was Iowa, they found that in the town in which they were resting over night the measles were very prevalent, and the good wife suggested to her husband that it might be well, inasmuch as the children must always have measles anyway, that they should stay there a few days until they were well inoculated. This they proceeded to do and when they resumed their journey, they left a trail of measles clear over to the Pacific coast. Now, of course we have outgrown all this and yet none of us would question the fact that we come pretty near that sometimes in connection with our modern means of transportation.

Not many years ago I had the unfortunate experience personally of getting into a car which had been in service sometime and contracting a very well developed case of whooping cough. I used to ride a bicycle at that time and it was not an unusual thing for a few weeks, that I would have to get off my wheel, lean up against a lamppost until I was through with an attack of whooping cough, and it lasted for nearly six weeks.

If the Commissioner were present; he would tell you that his observation and experience, especially since he became the Commissioner of Health, led him to attach very great importance to the questions of ventilation, especially in our homes and places of work. We do not get that control that we should have of the diseases which come from bad air, and one cannot attach too much importance to the necessity for fresh air.

My own point of view is something like this. In the last year or two I have had some special occasions to consult the authorities and make observations respecting vitiated air and it seems to me that, leaving out of the question the use of tombstones to which these gentlemen have referred, there is the question of efficiency, vitality, energy. I am sure that no man can approach a high degree of efficiency in his brain work or in his physical expenditure of energy who has exhausted the purity of the air of the room in which he is working or sleeping; that is, you cannot get 90 per cent energy out of a man who breathes 70 or 80 per cent pure air. That is a very practical way of putting it, and I am sure you will appreciate that.

The problem which the paper suggests is, of course, a very highly specialized problem—ventilation and heating. It is of course wise to separate them. They are two distinct problems and yet very closely related. The ventilation and heating of a coach differs with the rate of speed and of course it is altogether a different sort of a problem when the car is standing still, as Mr. Thompson so carefully points out, and yet those specialized problems are such that almost every day in the work of the Health Department we are trying to dictate, as we sometimes have to do, what should be done in the various conditions where the air is not what it ought to be; as

to the amount of air necessary to be supplied, of course our regulations must necessarily prescribe minimum amounts.

We have had in the Department, occasionally, considerable discussion over the minimum amount which is prescribed for the work shops. Five hundred cubic feet of space, four changes of air per hour, leaving only 2,000 cubic feet of air per hour, you of course realize is the minimum, as has been stated here this evening. I am sure that the suggestions which have been made respecting 3,000 feet per hour are not above what they ought to be, although it is of course to be considered in this connection that passengers in a coach are usually quiescent; they are not working, and possibly their brains are not particularly active, so that they do not need as much as a man who is operating a machine, for example, in a shop.

I thank you very much for your invitation to be present. I am sorry the Commissioner is not here to speak for himself, but I am sure that your intelligent study of this problem will lead to a very much greater appreciation of the more ordinary problems of our homes and offices and shops.

The President: I am sure the Club is indebted to the gentleman for representing the Commissioner. Is there any further discussion?

Mr. E. W. Pratt (C. & N. W. Ry.): It occurs to me, Mr. President, that in any solution of the subject of ventilation there will be some system, either of the exhaust type or intake pressure type most widely adopted, therefore I wanted to say a word with regard to some experience I have had lately in regard to the exhaust system.

I have had under my charge a motor car that has been heated by indirect radiation and ventilated by the exhaust system. This method of heating is very satisfactory for this car, except in very cold weather; that would indicate that the amount of radiation is not sufficient. The method of ventilation by the exhaust system is highly satisfactory, especially as the windows in this car are air-tight, but to my mind that has a great deal to do with the comfort of the passengers. With an exhaust system such as was spoken of, especially in connection with the refrigerator car, it makes no difference where the fresh air enters the refrigerator car, if it is through the cracks in the sides or eslewhere, as long as it gets through the load. But in a passenger coach, where a passenger next to the window has one arm and one shoulder exposed to the glass and the cracks about the window, we all know that the draft is quite disagreeable, especially with a single window, and I believe that we would quite generally agree that a single window is preferable to double sash if the former could be made satisfactory. As far as cleaning the car is concerned, it is much better and easier, and if the draft could be prevented and the dust kept out, there would be only the objection left of the steaming of the window. With better ventilation I do not be-

lieve that we would have that objection. Therefore, with an intake pressure system which would cause any draft in the cracks of the windows to be from the inside to the outside, I think that the single window would be highly satisfactory, and for that reason I am inclined to believe that a pressure intake system, either by means of the pressure acquired through the speed of the train or by a fan will have strong advocacy in the final solution of the matter of ventilation.

Mr. W. J. Schlacks (McCord & Co.): Some years ago I was fortunate enough to meet a doctor in Colorado, who later became a specialist in the treatment of consumption, and whose efforts since then I believe have been rewarded by the highest percentage of cures of tuberculosis. He practices the fresh air treatment, enlarging to some extent on the ideas imported from Nordrach, Germany. The idea was to have the patients live in a tent octagonal in shape, about twelve feet across the short diameter. This form rose to the height of six feet, from whence it slanted off to an ordinary hooded ventilator which was round. The floor of the tent was raised about 6 inches above the ground, allowing a free movement of air underneath. In each side of the tent, and near the floor, was a ventilator which allowed sufficient air under the tent at the floor, and left the tent through the ventilator on the top. In cold weather the vapor of the patient's breath could be traced in a direct line from the mouth to the top ventilator, although the patient was never in a draught. It struck me that possibly the same idea could be utilized with necessary modifications in the ventilation of a sleeping car; each berth section to be constructed so as to allow a draught to come up on all sides, and protect the passenger from the draught by a guard which would avoid the passengers projecting arms and limbs in line of the draught.

The President: I think this matter is one which is difficult to settle by discussion on the floor: it is one that is highly specialized and I have been wondering how this Club could express itself in answer to the questions which have been asked here, but I give it up. I had thought of taking perhaps a vive voce vote on the different branches of the subject, but on further consideration I am of the opinion that we can hardly express ourselves without more consideration. I think that the better way perhaps would be to discontinue the matter, unless some one has further information to offer, with the suggestion that any one specially interested in the matter address Mr. Thompson direct with reference to any points which occur to them, not covered in the discussion.

Mr. F. H. Clark (C. B. & Q. Ry.): I noticed Commissioner Evans enter the room; perhaps he will give us some further information on the question.

The President: Will Dr. Evans favor us with a few remarks.

Dr. W. A. Evans (Commissioner, Department of Health): Mr. President and Gentlemen—Some months ago I had the pleasure of reading the paper of the evening. From it I learned much concerning the ventilation of cars, and my principal object in being present this evening is, through the discussion, to still further add to my information on this very important subject. I regret that I have not been present during the preceding discussion, and I am afraid that, called upon as I am upon my entry to the room, I shall cover ground that has already been covered.

I believe that the ventilation industry is undeveloped. The sanitary engineer, the plumbing engineer, in fact, all those having to do with the body wastes except the ventilating engineer, have justified their existence. I do not believe that the ventilating engineer has justified his.

When we study the vital statistics of Chicago we are unable to find that bad plumbing and bad draining are responsible for any appreciable death rate. This is the more remarkable in that early in the history of Chicago it was badly drained and I believe in great measure dependent thereon there was a very high death rate. As drainage has improved the death rate has fallen. Of course, we recognize that hand in hand with the improvement in drainage there has been improvement in general hygienic conditions.

There is a group of diseases that are due to bad air, and in the general improvement in the death rate this group has not participated. I refer to tuberculosis or consumption and pneumonia. These two diseases, with bronchitis and influenza, were responsible for practically 10,000 deaths in Chicago during the last year. The figures show that the death rate from consumption is just about holding its own, whereas the rate per 10,000 living from pneumonia has increased from 13 to 23 in a quarter of a century. This is proof to my mind of my statement of a moment ago, to-wit: That the ventilating engineer is not justifying his existence.

When we come to study the chemical and mechanical sides of the question, in my judgment we find further proof. Most of the expensive structures are being ventilated upon the principle of dilution, and this, so far as practical conditions are concerned, is wrong in house ventilation as a general proposition and always and emphatically wrong in car ventilation.

The proper principle of ventilation is that the effete air just expired should at once be removed from the breathing zone and be conducted as promptly as possible into the outside air.

One thousand five hundred cubic feet per hour is usually held to be the amount of air required by a man at rest. This amount is far too little if the excretion gases are being kept in the breathing zone, and it is also too much by far if the excretion gases are being kept out of the breathing zone. Perhaps I can make the point plainer by saying that if the intake of water at a crib is from a mass of pure

water the volume can be small, but if it is from a mass of water into which some pollution goes the volume must be enormously increased.

It is possible that there might be circumstances under which the policy of dilution within a house could prevail with propriety. I say "possible" because in my judgment I have never seen a place in which it was advisable to apply it.

We are told that expired air tends to fall to the floor by reason of the CO_2 contained. An air which contained little or no CO_2 and to which four per cent of CO_2 is added, if the temperature remains the same and the barometric pressure were unchanged, would fall to the floor; but, on the other hand, the expired air is heated to 95 and 100 deg. and the heating lightens it to a degree which more than compensates for the increased weight of the contained CO_2. In fact, practically speaking about 7.4 deg. of heat will compensate for the weight of the carbonic acid gas. Therefore if the temperature of the surrounding air is from 85 to 90 degrees, the expired air will not rise, but anything under this will throw the expired air to the ceiling. I need not say that no human being should be forced to live in a temperature of 85 to 90 degrees.

Assuming, then, that the surrounding temperature is less than 85 degrees, the foul air will go to the ceiling promptly, and it should be taken from the ceiling, and any system of ventilation that forces this ceiling sewage air back into the breathing zone is inherently faulty, unless the possibilities of dilution are greater than I have ever seen them within a room. So much for house ventilation.

And now for car ventilation. The number of cubic feet of air space in a car ranges from a minimum of 10 in a crowded street car to the conditions that prevail in a Pullman, usually about one-half to two-thirds occupied. It seems to me to be quite possible that in a Pullman with eight to fifteen passengers enough air will leak in around the windows and doors and other fissures so that no intake system need be provided.

In a street car and in a day coach which is crowded this would not be true. In a street car operating on the dilution principle the content of air would need to be changed about one hundred times an hour. This the passengers would not stand in cold weather. I should say that a day coach with the ordinary load, using the dilution system, would need to have its air changed from fifty to seventy-five times an hour.

The principle proposed in the paper of the evening is not one of dilution. The taking in of the air near the top of the car away from the dust zone and the delivery of it heated near the bottom of the car, combined with an exit system at the deck sash, in my judgment is nearly ideal. It will require a very much smaller intake of air per hour than is required in the dilution plan, which latter plan is absolutely impossible with cars. The smaller quantity of air, it would appear to me, could be heated economically. On this point I am not quite certain, but it would seem to me to be good judgment that on

account of the lesser amount of air required, the cost of heating should be less than in the dilution plan.

I would suggest to the essayist that he add to his plan motors near the outlets—these motors to stop when the car starts and start when the car stops.

Much of the trouble with cars is due to influences that are somewhat aside from those of air; for example, I think cars are usually too hot. In fact, such has been my experience. And when hot, the humidity has been low. A hot air of low humidity is just as deleterious to health as a more vitiated air. We are not to lose sight of the fact that bacteria thrive in a hot air. Many of the odors of a car are due to emanations from the persons and the clothes of passengers, and these are never adequately cared for by the dilution system of ventilation.

THE PRESIDENT: As the author of the paper is not here, nor, as I know of, the members of the committee that have this actively in hand for the Master Car Builders' Association, and in view of the lateness of the hour and another subject to discuss, I would suggest that we defer the matter as suggested before the Doctor addressed us. Is there any motion from the floor in regard to further discussion of the ventilation problem?

MR. S. L. KLEINE, (Penna. R. R.): There is one question which has come to my mind after hearing the Commissioner's very instructive remarks, and that is in regard to the ventilation of the coach equipped with the Pennsylvania ventilating arrangement when standing still. When the car is in the station, it is generally there only for about five to ten minutes at the outside, during which time the doors are usually open, to discharge and admit passengers. It is also a well known fact that when the currents of air strike the globe ventilators which are located in the deck of the car to discharge the foul air, the exhaust takes place, so that if there are any currents of air stirring on the outside of the car a certain amount of change of air is taking place in the car.

THE PRESIDENT: Anything further, gentlemen?

MR. PRATT: I make a motion that the discussion close and any members who have anything further to offer, make suggestions direct to the writer of the paper.

THE PRESIDENT: Such will be taken as the sense of the meeting, unless objection is made.

The record of the last meeting shows that the discussion on the paper, The Car Wheel and its Relation to the Rail and Car, was carried over to this meeting.

For the information of the few present who were not at that meeting and to refresh the memories of those who were, it may be best to review the salient points of the discussion. The paper has been extensively copied and commented on in the technical press, and it

is unnecessary to repeat any of it. The discussion was mainly with reference to the wheel, itself, composition, design and performance.

Mr. Garstang, Chairman of the M. C. B. Committee on Tests of Cast Iron Wheels, and also a member of the American Railway Association Committee on Standard Wheel and Rail Section contributes a formal explanation and defense of the M. C. B. wheel, principally with reference to the coning and throat radius.

Mr. Manchester deprecated the idea that the cast iron wheel was past its usefulness even under cars of 50 tons capacity and expressed a belief in possibilities of improvement of the wheel as regards material and design.

Mr. Barnum presented some statistics in corroboration of the paper and spoke of provisions in the car and truck design which would reduce flange friction and relieve strains.

Mr. Schroyer emphasized the increased duty on wheels due to weight of modern equipment, and while not alarmed as to cost of maintenance, believes the flange question worthy of most serious study and consideration for improvement. He does not apparently place much value on frictionless center plates, etc., as a cure for sharp flanges. Doubtless this point may be enlarged upon this evening.

Mr. G. L. Fowler reviewed the cast iron wheel question and apparently believes them not strong enough for service under fifty ton cars. Not only that, but the heavier braking service on high capacity cars is a contributing cause to failure. He laid stress on the internal strains existing in a cast wheel and the addition to these strains by the heating of the wheels in braking. Some tests had shown that very great lateral strains were thrown on the wheel flanges by the nosing of the car on tangents, the amounts exceeding lateral strains noted on curves. An instance of curing this tendency by making the wheels cylindrical seems to prove the contention of the author of the paper.

The value of devices to assist the truck in squaring itself was touched upon and excessive side bearing clearance was condemned.

Attention was called to the impact load on wheels when heavily loaded and running at considerable speed. A comparison was made as to the relative tensile strength of steel and cast iron as materials for wheels and their behavior also as to their ultimate relative economy and safety.

Mr. T. A. Griffin gave an account of some of the difficulties in making good cast iron wheels, claiming that experience, correct foundry practice and handling from the time the iron is put into the cupola and the sand into the mold until the wheel is finally delivered from the pits can produce satisfactory results. He stated that it was not so much a matter of materials as it was of manipulation and that there is no reliable information outside of such experience in

wheel making. He, therefore, believes that the railroads have no knowledge or information on the subject by which they can make exact specifications, and believes they should confine themselves to getting the results and performance of their different makes of wheels, judging from that and from the general business standard of various makers as to their reliability as wheel makers. He takes exception to the claimed advantage of the thicker flange of the present M. C. B. standard and urges a more general and widespread study and interest on the part of railroad men in the wheel question.

Mr. Hennessey gave the wheel makers credit for great advance in their art and claimed that there was a less percentage of flange failures at present than when cars were lighter. Some causes for sharp flanges were mentioned and anti-friction bolster bearings were recommended.

Mr. De Voy spoke of the effect of additional coupler clearance as affecting flange wear, taking a position at variance with the generally received opinion.

Mr. Bush in closing covered the entire range of the discussion, and I must refer you to the printed proceedings for this as well as for more complete statement of what was said by various speakers.

We are now to undertake a further discussion of this very interesting subject, and prior to doing so I wish to speak on one phase of the question. The wheel, itself, has been quite thoroughly discussed and we have much food for study and consideration. I do not say that further discussion of the wheel will not be advisable, but doubtless the effect of various modifications of the car body and truck on the wheel could be gone into further with interest and profit. This will necessarily take us into the realm of patented devices. Outside of any business considerations we have to discuss the mechanical features of these devices in our offices, and I believe we can with equal propriety discuss these points on this floor without necessarily involving patent or business considerations. Unless, therefore, there is objection from the floor I shall recognize anyone who has something to offer in this connection, trusting that they will not abuse the privilege of the floor by introducing objectionable personalities.

The value of papers and discussions finally registers in the recommendations and practice of railway officers who are guided by the experience, either of their own or of their neighbors. It is necessary, therefore, in getting your neighbors' experience that it be reported correctly, and in this connection I wish to take issue with the editorial utterance in the Railroad Gazette of Feb. 14th, page 205, second column, reading as follows:

> "Again, in January, at the Western Railway Club, a paper was presented in which the causes of failure of the cast iron wheel were set forth with great elaboration. No ex-

cuses were offered, and the case was clearly and definitely stated. In the discussion that followed there was at least one vigorous attack upon the use of the wheel under high capacity cars, followed substantially by a corroboration, or at least, by no refutation of the arguments offered to show that the wheel was not safe. These straws are certainly very indicative of the opinions of men who know; for in both cases, if railroad officers present had held any opinions contrary to those expressed, or if the wheel makers had any figures or arguments to offer to contradict or meet the opinions set forth, these opinions and arguments would undoubtedly have been brought to light."

From this one would infer that no railway officer present at the last meeting had anything to say in defense of the cast iron wheel under high capacity cars.

This is not correct, and it is a fact as shown by the record, that no railway officer who spoke on this floor at the last meeting conceded the extreme position which would be the logical conclusion were we convinced of the truth of the premises advanced by the steel wheel people. It is true and speakers have admitted that modern car and traffic conditions require an improvement in the wheel as to design and material and also the need of considering such modifications of the car body and the truck as will favor instead of add to the shocks and stresses now conveyed to the wheel. The necessity for more study and attention, the collection of data and experiments was voiced by several speakers and I am sure we are not ready to admit that we are at the end of our resources and "resignedly accept" the present cast iron wheel situation as final.

It is a fact that most of the railroads actively represented in this club are not mountain roads and the fifty ton car is not preponderating in our equipment and we have not experienced the acute conditions which some of the roads in other sections have to meet. Otherwise, we would "have woke" up sooner perhaps. In any event, the general situation is not as bad as this editorial (of which I have quoted but one paragraph) would lead us to believe. The eloquent advocate for the steel wheel is not entirely disinterested, and we must admit that one prominent steel wheel maker knows the value of printer's ink and the editorial in question plainly misstates the situation.

All we ask, gentlemen, is a clear field and fair play. The steel wheel is a good thing and as such will find its field. It is even now badly needed under high capacity cars on certain roads having acute conditions of heavy grades, congested traffic and good net earnings.

We want steel wheels for heavy tenders and engine trucks, for first class passenger equipment, but I hope, as a result of the dis-

cussion on this floor of this admirable paper, that the correct status of the cast iron wheel may be established and ways and means suggested that will improve what is in general a very safe and gratifying performance of the humble cast iron wheel.

The President: Has Mr. Bush anything further to offer before opening the subject for general discussion?

Mr. Bush: I would rather not discuss the matter now, I would rather listen to what others have to say. I appreciate very much the opportunity you have given me, but I would rather hear what the others have to say.

The President: The Secretary has some communications that might be read at this time.

The Secretary: Following your suggestion, I have a couple of communications, one of which is from Mr. H. M. Perry, of the Perry Side Bearing Company.

Mr. H. M. Perry: In the very interesting paper by Mr. S. P. Bush on The Car Wheel and its Relation to the Rail and Car, read before this club at its last meeting, special attention is called to the failure of cast iron wheels due to the flange wear and breakage, in which it was shown that from 50 to 80 per cent of all wheels are removed for worn flanges.

It is undoubtedly a fact that the substitution of steel wheels for cast iron would reduce the *danger* from broken flanges, but the trouble with worn flanges would only become greater, due to the additional cost of the steel wheels as well as the fact that a steel wheel will wear faster than a cast wheel when it begins cutting against the flange.

It is also a fact that the resistance of trains is diminished when the side-bearings are free, but how long can the side-bearings be kept free? No form of construction, up to the present time, has been designed that will keep these bearings free for any length of time.

Under these conditions, would it not be in order to look more fully into the question of providing a remedy to overcome the resistance to the pivoting of the truck and wheels to the track, by the use of some of the so-called frictionless side-bearings? Several designs have been in use for a number of years past, so there should be no difficulty in securing reliable data as to results obtained by their use. The tests referred to by Mr. Bush as having been made on the Pittsburg & Lake Erie R. R. only serve to corroborate other tests made since that time.

One of the large Southern Coal roads, a few years ago, placed an order for 2,000 hopper cars, of 100,000 capacity, 1,000 of these cars were equipped with frictionless side-bearings and the other 1,000 cars with ordinary rigid bearings. At the end of about two years, over 32 per cent of the wheels, on the rigid bearings cars had

been removed for sharp flanges, while only about 3 per cent of the wheels under the cars equipped with frictionless side-bearings had been removed for the same cause. These cars were in the same service and operated under the same genral conditions, and only serve to emphasize the results obtained by several other tests of the same kind on other roads. I think Mr. I. C. Hubbell of the Kansas City, Mexico and Orient Ry., has some information regarding similar results obtained on his road.

As long ago as 1898, a series of careful tests were made by Mr. H. M. Pflager, at that time Chief Mechanical Inspector of the Pullman Co., a report of which was published in the proceedings of the M. C. B. Association of 1903. In these tests he shows an increased mileage of from 11 to 14 per cent due to the use of frictionless side-bearings. As these tests were made on the Chicago and New York Limited trains, which trains probably had more careful attention paid to them, regarding their general running condition, than any other trains in the country at that time, the figures given can be taken as very conservative. A remarkable feature of this test was the fact that on the cars with rigid bearings the bearings were kept free as far as possible.

It is reasonable to assume that a large amount of power is required to cause this excessive flange wear, and in order to demonstrate this fact, a series of tests were made on the Santa Fe Road, a report of which appears in the 14th Annual Report of the Travelling Engineers' Association. This report says that "an increase of about 7 per cent tonnage can be handled over a divsion having a number of curves, and that on a 6 degree curve an engine can start fully 100 tons more in cars having roller bearings than in those having ordinary flat bearings. It was also shown that a train moving eight or nine miles an hour on a tangent, with common side-bearings would be reduced to 1½ to 2 miles per hour, when passing curves, but with roller bearings the speed would only be reduced about ¾ of a mile."

This reduction in power is also shown on a test made on the Metropolitan Elevated Road of Chicago, by one of the electrical engineers of the Westinghouse Company. In this test cars were equipped with volt meters, so that careful measurement of the current could be made, and it was shown that an average of 17.8 per cent less power was required to handle the cars equipped with roller side-bearings on curves than the cars equipped with ordinary rigid bearings notwithstanding the fact that the rigid bearings were well lubricated and had a clearance of ¼ inch between body and truck bearings.

In one instance, on a curve 260 ft. radius, 29 horse power more was required to operate the rigid bearing car than the one equipped with roller side-bearings, while on a straight line, the difference in

power required to operate the two cars was less than one per cent.

In view of the tests recently made by Mr. Geo. L. Fowler of New York on the stresses to which car wheels are subjected in service and the results obtained, showing only about 1.5 to 2.5 per cent as a factor of safety under certain conditions which are liable to occur, and which might offer an explanation for many of the unexplained derailments, is it not the duty of every railroad mechanical man to at least try to reduce this danger by any means at his command?

Objection is made to the application of frictionless side-bearings on account of first cost, while any of the above quoted tests show that the expense of their application would be covered within the life of the first set of wheels, under the cars. Another objection is that none of the present designs of frictionless side-bearings have proved successful in service, notwithstanding some of them have made over 200,000 miles under the heaviest equipment and are in perfect condition, while others have been in service from three to four years under equipment weighing, under load, from forty to one hundred tons and are still in service. This does not refer to a few sample bearings but to thousands of bearings in use on several of the large trunk lines.

It must be conceded that more or less failures have occurred to all of the different designs of frictionless side-bearings, but where is a successful device in service today that has not met with a partial failure during its development and whose present success is not due to the experience gained at that time?

Why does not the Committee on Centre Plates and Side-Bearings of the Master Car Builders' Association, suggest a series of tests of the different designs of frictionless side-bearings, applying them to cars or trains on different roads under varying conditions and arrive at some definite results? Undoubtedly, all of the manufacturers of side-bearings, would gladly furnish any number required for a test of this kind, without any expense to the company using them except the cost of application. In this way, much valuable information could be gained without much expense to the companies making the tests.

The Secretary: I also have a letter from Mr. Hubbell referred to by Mr. Perry.

Mr. I. C. Hubbell: I am very sorry I can not attend the Club meeting tomorrow to participate in the further discussion of the very able paper presented by Mr. Bush upon a very live topic, The Car Wheel.

It is a somewhat remarkable fact that railway companies are slow to accept and adopt innovations and it is a question to what extent the air brakes and M. C. B. couplers would be used at this date, had not national legislation made their application a necessity in interstate commerce.

In the paper before the Club and in its subsequent discussion much general information is presented for the consideration of all concerned. From 1881 to 1883 I was connected with the Denver & Rio Grande Road This line as you know operates largely in the Rocky Mountains and the car wheels are subjected to brake pressure continuously for long distances. It was then found necessary to secure our car wheels from a remote point on account of our not being able then to obtain wheels that would stand the heat and the sudden plunge into snow that frequently resulted but other wheel makers now meet that combination of conditions.

I do not consider that the cast iron wheel is a relic of the past nor that its future is as a curiosity in our museums as predicted not long since by an Eastern orator as regards the locomotive, but I do think now, as years ago, that in the design of our cars we can very easily insure a longer life to the cast iron or the steel wheel by the design of the car trucks and the manner in which the bodies of the cars are applied to the trucks.

Mr. Bush alludes to this pointedly I think and the point is emphasized by some of the gentlemen who spoke at the last meeting.

In 1897 and 1898 I purchased from the Pullman Co. the Missouri Car & Foundry Co., and the Barney and Smith Car Co., a large number of the then standard M. C. B. thirty-four feet, thirty ton cars. In these were box, stock, gondola and flat cars. Under these cars I used a type of pedestal truck with side frames and transoms of pressed shapes, the springs being applied directly over the journal boxes, the springs being divided, using either four coil springs or two elliptical springs over each journal. There was no truck bolster but the bottom center plate was carried on the truck transoms.

The body bolsters were of a pressed form eye beams. The lower side bearings were carried on the truck transoms.

The light weight of these gondolas was an average of about 29,500 pounds and on our own line we regularly loaded these cars with 70,000 pounds of coal, piling on other materials for any point on our line The wheels, axles, sills, etc., were all of the M. C. B. standards prevailing at the years mentioned. When these cars were first put into service on our line the yard men at the mines and other points first called attention to the fact that our switch engines would easily handle two and three more of this class of cars around the curves, yards and mines than was possible with our other cars with the diamond arch bar truck as then made, although many of these cars had steel body and truck bolsters.

In the past year I have examined at least twelve of the cars purchased in 1897 and 1898 with the steel trucks and bolsters and under each of these cars I found the eight original cast iron wheels, and an examination of the flanges in each instance gave me a glad sur-

prise, for there, to my mind, was a full justification for the use I had made of the trucks and bolsters herein referred to. The wheels under the Pullman built cars were made by Griffin and the car builders made their own wheels for the other cars.

The car truck must hold the axles parallel to each other. The truck must be free to maintain its position parallel with the track and so hold the axles at right angles to the rails and this will reduce train resistance which alone is worth the price, and at the same time reduce flange wear and prolong the life of the wheels. I have used for five years past the ball center and side bearings mentioned by Mr. Bush. We have a number of freight cars which have been in service for five years and we have not yet purchased a wheel to replace a wheel with a sharp flange from under one of these cars.

These cars all have the usual arch bar diamond trucks, with cast steel body and truck bolsters. The pressed steel truck I have referred to is not now manufactured, so far as I know.

Personally, I believe that the car wheel, cast iron or steel, is by no manner of means solely at fault in the case of failures and I believe, that, with the removal of the element of friction between the car body and the truck, coupled with a truck that is square and which will remain so, the wheel difficulties even as they now exist are already largely overcome.

Edward C. Schmidt (University of Illinois): Mr. Bush suggests a reduction in the brake shoe bearing area as one means of alleviating the stresses which lead to flange failures. It seems certain that he is correct in stating that unequal heating of the wheel rim will introduce a stress near the point where the greatest difference in temperature exists.

I understand that his purpose in suggesting a change of brake shoe contact area is to move this point of maximum temperature difference away from the base of the flange in order that the stress due to heating will not coincide in position with the stress due to the concentrated load on the wheel.

It seems to me that this same purpose might be served if the brake shoe contact were so increased as to cover the entire surface of both tread and flange, in order to more equally heat the entire rim. This probably would also decrease in amount the stress due to heat. This stress is due, I should suppose, not so much to heating in itself as to *unequally* distributed heat which will result in unequal radial expansion. Possibly, however, it might be practically more difficult to increase than to decrease the shoe contact.

Mr. E. S. Woods (E. S. Woods & Co.): Mr. President, in regard to Mr. Perry's statement that it is practically impossible to maintain the modern bolster with side bearing clearance, I will say that in my experience—and I have watched that pretty closely—it is a fact that clearance is maintained quite well on the newer de-

signs of the steel bolsters, both of the built-up and the cast steel types.

It is stated in his letter that after two years, I believe, 32 per cent of wheels were removed for sharp flanges in connection with the friction side bearings while only three per cent were removed from cars having anti-friction side bearings. That seems to me, from my knowledge of the subject, to be a very wide difference and it must be a pretty bad lot of wheels and an exceedingly curvey road and poor bolster conditions that will require 32 per cent removal for sharp flanges in two years.

The consideration of devices for the minimizing of flange wear, stresses on the flange of the wheel, draw-bar pull, etc., takes us principally to the consideration of anti-friction center plates, anti-friction side bearings and lateral motion devices. I have had a little experience on pulling tests with a dynamometer car. One of these in connection with a lateral motion device, showed that the anti-friction or lateral motion devices developed greater efficiency on tangents than they did on curves. I do not have the figures to state just exactly what the conditions were, but roughly, the efficiency shown on the tangents was five per cent and on curves about two per cent. The average for the entire run was about three per cent. The road was very crooked and grades heavy.

In regard to side bearings, I have been connected with several tests, the idea in view being to find out what there was in an anti-friction side bearing device, principally in regard to flange wear and drawbar pull. Of course a test of this kind is important only as it relates to the specific conditions under which you operate, and I can cite briefly one, a pulling test, made on a road consisting of about half tangent and half curve, with heavy grades, where we handled about twenty-two loaded 30-ton cars. The average of the first run, corrected for grade, speed, etc., showed 11.2 per cent in favor of an anti-friction side bearing device, and on the second run 9.6 per cent, or an average of about 10 per cent. But these were under rather extreme conditions, heavy curves, heavy grades, curve and tangent about equal.

Some time ago I made a determination on about 200 wheels to get at the question of flange wear. I reduced the problem to the consideration of the wear of the flange and tread in fractions of a square inch per thousand miles, taking a templet from each wheel as it went into service and as it came out of service and taking a record of the mileage and then figuring the area with a planimeter and obtaining what I designated, for want of a better term, "square inch wear per thousand miles." Both anti-friction side bearings and flat side bearings were involved, there being no anti-friction center plate under any of the cars. The cars involved were long, heavy passenger equipment, having 6 wheel trucks and steel tired

wheels. The road was reasonably straight with practically no sharp curves. The result of the test showed 37 per cent flange wear reduction in favor of the anti-friction device. These figures are only applicable to the specific condition of the roadbed, track, curve and tangent that were under consideration at the particular time.

The Master Car Builders' convention of 1900 has in its proceedings a rather interesting test of letting a freight car drift down a five-foot rise onto a short 15-degree curve, then run out onto a tangent. Of course this is all in the proceedings, but the car with flat side bearings having clearance ran 345 feet; the same car with flat side bearings with no clearance ran 175 feet, and the same car with anti-friction side bearings having some clearance ran 345 feet and 6 inches, practically the same as the flat side bearings with clearance. This car was loaded with 100 wheels in each end and the load was pretty evenly distributed, so that the car did not list over onto one side and throw the side bearings on that one side of the car into contact; in other words, it had a chance to balance up pretty well and right itself, under which conditions we would naturally expect that it would run nearly as far as with an anti-friction side bearing, but a great deal farther than with an ordinary flat side bearing, just as the experiment proved.

The tests on the P. & L. E. R. R. are full of interest, but they have been pretty fully discussed in the proceedings. I have in mind another test to determine the basis of merit of anti-friction side bearings in regard to wheel wear, made by a large company in this city, and the results showed just short of 20 per cent in favor of the anti-friction side bearing.

It may be interesting to add that I have recently had an experience trying to compare anti-friction bearings with flat bearings as affecting flange wear. The cars were equipped with cast iron wheels of different make. This was sufficient to destroy any definite results from the test, and as a wheelmaker said at the last meeting, there are certainly two kinds of wheels.

Mr. J. F. DeVoy (C. M. & St. P. Ry.): I did not think the subject would resolve itself into anything more than the relative condition of the wheels. It appears from the communications that it has resolved itself largely into the question of side bearings. The question uppermost in my mind for the past five years has been, how does any man attempt to measure drawbar pull between an anti-friction side bearing and an ordinary side bearing? I have maintained during that time, and under the greatest objection from different parties, that the question of tractive power or resistance of cars and the relative condition of the wheel bearing against the rail was not properly measured. I believe that there is no proper method of measuring that per centage.

To make myself clear and that I may not be misunderstood, I

want to say that I am not opposed to an anti-friction side bearing or center bearing; they are good things, but I do want to call attention to a period of five years in dynamometer tests, the last of which occurred not less than two months ago, when we began at eight o'clock in the morning, worked through the day and into the next morning, and it was clearly demonstrated that on a 1,400-ton train, the drawbar pull did vary 4,500 pounds in a total tractive power of 38,000 pounds, and that it was due solely to the temperature or condition of the axles and bearings during that test. We handled the same train for four tests and with the same engines. The maximum tractive power exerted on about a five-tenth of one per cent grade in the first test was 38,000 pounds; in the last test, with identically the same train, with one car exception, (one car was set out for a hot box, and we took identically the same type of car, the same load), the maximum tractive power exerted on that same grade was 32,000 pounds, or 6,000 pounds difference. So I maintain that any measurement in per cent that has been made up to date with anti-friction side bearings as against one of the ordinary type is not exactly to be relied upon.

There are so many other conditions entering into the resistance of trains, that it is an absolute impossibility for any man to say that any side bearing or any part of a car will absolutely eliminate 15 per cent or 20 per cent or 25 per cent tractive power or resistance, or whatever we desire to term it.

In a series of nine tests, conducted on a division where 62 per cent was tangent and the remainder curves, the average drawbar pull per ton of train was 4½ pounds in an average test. On another railroad where anti-friction side bearings and anti-friction center plates were used, 4⅞ pounds per ton of tractive power was noted. I think that any man who states the difference in resistance due to the different side bearings or center plates, does not know just exactly what he is talking about. I can go out today, if the temperature this morning will be zero, and start a train of 1,400 tons, up a five-tenth of one per cent grade, and run that train 75 miles until it has become warm, and is lubricated properly, and the tractive power will vary possibly as much as 10,000 pounds, or 25 per cent of the total. Now, do not misunderstand me, because, as I said in the beginning, I am not opposed to an anti-friction side bearing or center plate; they are a good thing, but "render unto Caesar that which is Caesar's." Let us see how much of this 25 per cent, or 37 per cent, as the last speaker or some other speaker said, is really attributable to anti-friction bearings, because if it were true, we would commence tomorrow to equip all our cars with those bearings and we would save lots of money, in fact more than you could by any bond issue in the world.

Mr. Woods: I think Mr. DeVoy misunderstood my remarks.

The 37 per cent which I cited referred to flange wear, not to tractive power. The tractive power differences which I gave were 5 per cent and 10 per cent. In regard to the physical conditions obtaining, these tests were all made in the summer time when the temperature was practically constant, the rail conditions were as near constant as possible. And I want to say further that I intended to convey the idea that the tests as I referred to them, were of no particular value in the abstract; that they simply covered specific cases, in an effort to get as good an answer as possible to a question that is very little understood.

Mr. DeVoy: I hate to ask the privilege of the floor the second time, but my friend Woods was watching me, and I was afraid he thought I was referring to him, but I was not. I agree with nearly everything he said, and I do favor an anti-friction side bearing, so that I do not think he will have any hard feeling against me. But he kept his eye on me all the time and I thought I was in for it. I call a device a device. It was that side bearing fellow that I referred to, and not Mr. Woods. If his side bearing reduces flange wear 37 per cent let us say so, but it doesn't do it. I can show any man if he cares to take the time the difference between the same train under varying temperature of say 30 to 40 degrees; I will show him also the difference in ten miles of travel.

Mr. B. D. Lockwood (C. C. C. & St. L. Ry.): I attended the meeting for a definite purpose tonight, as the Chairman of the Standing Committee of the M. C. B. Association on Cast Iron Wheels and whom I represent, could not be here, and he thought some representation necessary since the subject was going to be confined to the cast iron wheel, which is a very live one, especially to us.

I say "to us," meaning Mr. Garstang and myself, as the M. C. B. Committee, has always been kind enough to take me along as a sort of Secretary and as a consequence, I have attended all of their meetings since June, 1904.

There are quite a number of points as we read the Club's reports published since Mr. Bush's paper was read that possibly we may have misinterpreted, and I have therefore marked one of the last proceedings for comment here tonight.

It would make a long story if I were to go through the subject of the investigation of the cast iron wheel by the M. C. B. Committee from the start, but it will be necessary to review a portion of it, to show why the points I mention as we interpret them were incorrect.

At the time when the standing committee on cast iron wheels was appointed by the M. C. B. Association, or in other words during the years 1902, 1903 and 1904, the Committee was given an opportunity to invite at its pleasure the cooperation of the manufacturers, and they did so. At that time I did not happen to be associated

with the Big Four, and consequently was not with the Committee but the joint meetings, or at least the consensus of opinion deduced from the joint meetings, were published in the Committee's report to the M. C. B. Association.

Since 1904, I have been present at all of the meetings, not only of the M. C. B. Committee alone, but those composed of the joint Committees appointed by the American Railway Association, of which the M. C. B. Committee on this subject are members. The joint Committee has studied the problem very thoroughly and is not through with its investigations to date so far as the rail portion of the subject is concerned.

At the meetings of the M. C. B. Committee, we have had a Committee of the Manufacturers at the majority of the sessions which will enable me to say something on the following: Mr. Griffin, on page 166 of the last Club Proceedings says: "Railroads have had a great deal to say about the car wheel; what it should be made of and what it should be made in, but what do they know about it compared with the man who spends his life on it?" Up to the question contained in the latter portion that is right, but when a Committee of the M. C. B. Association on the subject of cast iron wheels, calls a joint Committee from the Manufacturers and listens to everything they have to say pro and con in order to bring out the necessary information, before getting down to work out their report and after it has worked out the report, put it up again to the manufacturers and tell them what they propose to do, asked the manufacturers for comments, and the manufacturers make no comments and endorse the proposed action of the Committee, it does not seem that Mr. Griffin is correctly reported and I am very sorry he is not here tonight to sustain his point if he means it that way, and in the absence of Mr. Garstang, I am willing to make myself a target and will answer any questions propounded by the members that I am able to answer.

The car wheel, in a general sense, to quite a number of the railroad fraternity, is a block of iron with a flange on it for which a certain number of dollars is paid to secure running results and get the guaranteed mileage of the wheel under the purchased price, and it makes little difference to those persons, whether the wheel is made out of glass, tin, steel or paper, providing it is a car wheel, but so far as the M. C. B. Committee is concerned it certainly has been investigating the cast iron wheel and will continue to do so until the subject is finally disposed of to the fullest extent of which the Committee is capable.

At the outset, full sized drawings from different railroads and car wheel makers of the different wheels they were using were secured by the Committee and there were 117 wheels of different types so reported. Out of the 117 wheels, of which templets were made, a

composite wheel was formed for each of the respective weight of wheels and these composite wheels were used as a base to frame the Committee's recommendations, and these recommendations after being discussed before the manufacturers' committee, were reworked for a finished report, presented to the M. C. B. Association and adopted. At that time there were no adverse comments on the wheel and after adoption by the Association the only requirement was to increase the strength of the flange, instruction on which was handed to the Chairman of the Committee in 1905 and the Committee proceeded with its work on this line and asked and secured the co-operation of the manufacturer's committee for that purpose.

The manufacturers' committee had representatives from the eastern and western makers and all of them had a chance to argue on the proposed strengthened flange from any point of view and at the final meeting they knew definitely what the committee was going to do, and there was but one dissenter on the manufacturers committee on the proposed strengthening of the flange.

One of the points I have marked reads as follows: "The flange of the wheel is just the size that it was 50 years ago, while it carries 50 tons running 20 miles an hour, where it used to carry less than half that amount running 10 miles an hour."

In commenting on this, I wish to say our forefathers when they started out in railroading believed in a factor of safety, figuratively speaking, that was way up in the clouds, and as we today increase the load on the wheel we reduce this factor of safety coincidently, and if we refer to the Purdue tests which Mr. Bush quoted, in order to find out what is the strength of the flange and sift them down, it will be shown that the average strength of all the wheels grouped is 60,000 pounds and of these the greatest majority were made in 1902 and earlier, or possibly up to 1904. In Mr. Garstang's comments on Mr. Bush's admirable paper which was read at the last meeting, you will find that he says that if a group of wheels made in in 1904 from the M. C. B. Association standard is averaged from the report of the wheels tested at Purdue, the average will be found to run up to 101,000 pounds instead of the 60,000 pounds reported.

If we take the 60,000 pound average strength of the flange shown by original wheels cast prior to 1902 or 1903, then go to work and redesign the wheel and get a value in the increased strength of flange of the 1904 type up to 100,000 pounds, it certainly is an important step and if we then go to work and add to the gray iron in the wheel beyond the limits of the chill and wherein the strength but not the wearing qualities of the wheel lies, in a similar manner to the present standard of the M. C. B. Association, I will say that the Committee or at least Mr. Garstang and myself confidently think that 10 per cent more strength or 110,000 pounds will be the result.

In the Purdue University tests referred to, I think I am correct

in saying that the Chairman of the M. C. B. Committee on Cast Iron Wheels is the gentleman who advocated such a test first and the machine for performing the work was designed by Professor Goss, and after the machine was completed, I had the opportunity to witness several of the tests and from those tests we secured on a reasonable basis the stresses that the flanges of the different wheels would stand.

About two months ago, I witnessed some tests of electric locomotives on the Pennsylvania Lines east and in which that Company had gone into their usual exhaustive research, at great expense, in order to get actual stresses on track rails, and I think I am correct in saying that the stresses were found to be under 30,000 lbs, with heavy locomotives averaging somewhat over 50,000 lbs. per pair of wheels.

From this test, I went to another point and saw Mr. Fowler's machine for the same purpose operating under stresses produced by an electric locomotive and I do not think I am incorrect in stating that he did not get over 19,000 lbs. stress, but I am not sure of this and would like to have him either support or refute it. In either case, that is 19,000 lbs. for one and 30,000 lbs, for the other resulting from a long rigid wheel base or in every sense a strictly non-flexible machine, you might expect, roughly, that 25,000 lbs. would be the maximum that would be sustained by a bad thrust resisted by the flange of a car wheel and if we take 100,000 lbs, as the capacity of the wheel you will find a factor of four for safety in the car wheel of today.

As far as the life of the car wheel, that is, cast iron against steel wheels—is concerned, I may say that the Big Four Railroad is satisfied with the cast iron wheel in freight service and they have been using since 1902, 700 lbs. cast iron wheels upon 7,500 gallon locomotive tanks and they have yet to find a flange failure under those tanks and as a result they are putting this class of wheels under the tanks of all locomotives in freight service today and will maintain them until instructed to do otherwise as they can afford to pay $10.00 per wheel and get its scrap value after wearing out, a great deal better than they can afford to pay $40.00 to $45.00 per wheel for steel wheels and they consider that it is equally safe for the safety of the trainmen.

Mr. Garstang was very anxious to be present at this meeting to personally take part in the discussion, as he considers the subject of the cast iron wheel is the most vital one before the M. C. B. Association today, and whenever the design of the wheel, coning of the tread, strengthening of the flange, or the weights advocated for these wheels are touched upon, he is always anxious to co-operate and lend any assistance or receive any suggestions that may be presented, and I should like to add if there are any further suggestions

we want to hear them as we do not wish to have the present M. C. B. standard wheel commented on without putting the commenter straight from the Committee's point of view, and we very much regret that both Mr. Garstang and myself were not present when this paper was originally read as Mr. Bush could not have presented a paper on any subject that we appreciated more.

THE PRESIDENT: We are very glad to have this expression from one who is so closely connected with the work of the M. C. B. wheel committee, and I am sure we all regret that Mr. Garstang is not present to assist in this discussion.

I am of the opinion also that the most interesting portion of the discussion is relative to the wheel itself, although there is also a relative value to the matter of details on the car and truck which will assist in reducing the stresses under which the car wheel has to labor. I think we have lost sight to some extent of some elementary features in connection with the wheel. What is the flange for? As I take it, it is to guide the truck in the case of entering or leaving track curvature. Normally the flange ought not to touch the rail at all on a tangent if the wheels are perfectly mated, and maintained so by the rigidity of the truck, and there should be no flange wear. I heard recently of a case where some passenger cars were equipped very carefully with selected wheels, all of which were mounted in the lathe and perfectly trued, trucks were carefully gone over and these passenger train cars ran from here to the West coast and back several trips without a sign of flange wear. Now, it is true in that case that those trucks "tracked," as it is expressed in Mr. Bush's paper, and there is no reason why a freight truck, if the same conditions prevailed in regard to the making of the wheels, would not track, and it is my opinion that there is stronger evidences for a cylindrical wheel with proper care in mating giving better life for flange wear than is possible by any coning. If there is any variation in the size of the two wheels, it is apparent the coning will tend to make those wheels ride on the rails in such a way as to bring the proper diameters to bear. Now, if one wheel is larger than the other, it will throw one of those wheels toward the rail and flange wear will ensue. In other words, the truck does not track and it would seem to me therefore, that a great amount of flange wear could be obviated by more accurate and correct methods in mounting wheels.

While in the Southeast section of the country on the Norfolk & Western Road, I had occasion to see under 50-ton cars a great many of the failed wheels with the familiar blue crack that is in evidence on those mountain roads, and I believe that Mr. Bush's analysis of the origin and spread of those cracks is perfectly correct, and I have no doubt but that a modification of the tread and of the brake shoe so as to relieve the throat of the flange will be of very great value. I believe further that there is a great deal

in the manufacture of wheels which must be carefully watched by railroad companies, as there is not an equality in the workmanship and character of wheels made by different makers. We all have our personal preferences for our articles of wearing apparel, for furnishings of different kinds based on our own ideas of the excellence of different producers, and there is no question but what there is a different degree of excellence and character in the product that is obtained by different wheel makers.

We have had occasion on the Rock Island Road to remove a great many wheels from cars turned out at a certain point, that leads us to to believe that there is something radically wrong in the practice of that company and which we cannot put our finger on, except that we know the results, and I think there is very good sense in what Mr. Griffin said, that the railroads should take more care of their records and ascertain what different makers of wheels are doing. Not that I would of necessity expect Mr. Griffin's wheels to be better than anybody's else wheels, but I believe we should know by statistics which can be made available for this purpose and ascertain what the performance has been. Is there any further discussion?

Mr. Manchester: Barring sliding, for which the wheel is not responsible, there are three principal causes for the scrapping of wheels, viz., seams, which finally result in broken flanges or rims; worn flanges and worn through chill.

As has been shown in the paper, which I believe is borne out by the records of most of the railroads, flange wear is one of the principal causes for the scrapping of wheels, and I fully agree with what was said by the President, that considerable of this, or at least most of this can be overcome by the careful and proper mating of wheels, and the maintaining of the proper and careful mating of wheels.

I believe today that it is more a question of maintaining the careful and proper mating of the wheels than the original mating. My observation goes to show that the majority of wheels that are mated do not wear exactly alike, that is, one wheel wears faster than the other, and though it may be mated correctly at the start and may start to run straight, after a time the wheel that wears the fastest will take toward the flange and without that wheel is withdrawn and remated with a wheel that is apparently wearing the same contour and of the same diameter, it will keep on crowding the flange and grow worse.

I believe one of the great things that a railroad can do today would be to watch that feature closer and remove the wheel and remate it whenever it shows a disposition to run to one side. I do not believe that it is one time in fifty that the truck itself is responsible for the wheel wearing toward the flange. If the truck

was responsible, then, if we would take the wheel out and turn it around, the opposite wheel would be the one that would commence to take on the flange wear. I presume every railroad man has tried that experiment time and again, and he almost always found that the wheel again went toward the flange.

I wish to add one more word while I am on my feet relative to the proposition of coning the wheel. As has been said by other speakers, the coning of the wheel is for the purpose of adjusting to same diameters. If the wheel would remain coned for any length of time, that might be a remedy, but it does not do so.

If the wheel could be followed a very short time, the coning is lost and it becomes a flat tread wheel; it conforms to the general shape of the top of the rail, and the less surface it presents to the rail, the area of contact with the rail from the beginning, the more quickly the coning will wear away and assume a contour that will give it the greatest possible contact with the rail.

We have all had an opportunity to watch tire wear and know what a radical difference it makes with the wear of a tire if the engine is run on a 100-pound rail or on a 60-pound rail, simply because the 60-pound rail presents a much less area of contact to the tire, and the smaller the contact the more rapid the wear of the tire.

As to the other feature, seams, that is a harder question to solve, and I believe has to be gone into more on the lines of manufacture of the wheels. I believe that here is considerable of the trouble, perhaps not all. Mr. Bush's outline of a possible cause may be a very good one. If it is, the best remedy then in the world, is to start out with the largest possible contact with the rail.

There are other causes, but they are largely reduced. When you mate your wheels properly, and keep them mated properly, and keep the flange entirely away from the rail, there will be less seams developed.

In the manufacture of wheels there are a good many terms that are purely manufacturers terms for defects, and being somewhat of a manufacturer of wheels, I feel at liberty to use them. Mr. Griffin gave you, and told it in a very funny way—a good many of the ailments that lead to the defects in wheels, or the trouble in making wheels. Take for example, a break down. There are several causes for a break down that are purely a manufacturing defect, or a manufacturing loss.

Not being careful in putting on clamps on the moulds is quite often one of the causes for a break down.

The cope and chill not coming down squarely over the axle core, or by striking the cope or chill.

A blown hub is caused by wet sand or core not properly baked, or vent not taken properly from core.

A blown rim is caused by wet sand, hard ramming, cold iron or iron being in a sluggish condition.

Light plates by chaplets not set properly, causing core to be shifted to the bottom of the mould, or the iron being poured too hot and burning off the chaplets.

Light flange; by bottom plate not being properly bedded. Too much sand will cause light flanges and not enough sand will cause swollen flanges.

Run outs caused by clamps getting loose on mould, or by mould being dressed too low.

Swollen rim; improper ramming, leaving a soft place on the rim, or on account of soft ramming.

Sand washes are caused by a break in the sand between brackets.

Taken out too hot; moulder being too hasty to get through with his work, the wheel bleeds.

Rough surface; moulder not cleaning the chill properly, or caused by cold iron.

Slag in the hub, is caused in the pouring, due to moulder not keeping the head full of iron while the pouring is going on.

Throat crack, is caused by low chill.

Chill crack; old iron, or iron being in sluggish condition or by pouring too hot.

Hard wheel; chill being too high causing cracked brackets, or due to bed getting too low and allowing the blast to strike the iron, or a large piece of iron sometimes getting too near the tuyers and changing the course of the air currents, or the coke not being able to carry the burden, or coke being high in sulphur.

Those are some of the causes that lead up to a foundryman's defects and where the wheels are made by the piece, the company usually has to stand the loss from iron too cold, or hard iron. The moulder has to stand nearly all the other losses, because they are moulding defects.

Did any of you ever give a thought to the amount of work turned out as a day's work by a moulder and a helper?

When you come to figure that these men put up work representing 17,000 pounds of metal a day, you can imagine that they have got to work pretty fast, and I sometimes think that the demands for such a large number of wheels for a day's work is being paid for often by the railroads in a poorer class of wheel.

But there is one other thought that I meant to refer to before I got this far, and that is one of the causes of seams.

If, in the pouring of a wheel, the flow of the metal stops for an instant, there is very liable to be a crack, or internal strain, or a cold spot in that part of the wheel, and it may be so covered that it is not seen until it fails in service.

To overcome that feature it is the practice in our foundry to re-

quire that a wheel shall be poured in nine seconds, and in our every day practice I think, as Mr. Bush will bear out, as he knows what was our practice in former years, we come very near to meeting that time. That is set at nine seconds; the man must not for one instant fail to have his head full of hot iron until the wheel is poured.

Referring then to the losses due to moulding and the foundry losses, I have before me the January statement of our foundry, showing the total number of wheels cast during that month, and I will say that this was one of our very lightest months; we were working only about three days a week. The statement shows that 5,128 wheels were cast and there was a total loss of 69 wheels, or 1.34 per cent of the total. The company stood the loss for three wheels and the moulders 66. The losses run: break downs, 23; light plates, 2; run outs, 2; swollen flanges, 2; sand wash, 18; slag in the hub, 7.

Every one of those slags in the hubs was due to the way in which the iron was poured into the mould, and whether there was any other causes that lead up to a seam we will not know until some later time. In these losses there were three men who had made 255 wheels apiece, that had no losses at all. The heaviest loss sustained by any moulder was 7, of which he had to stand the loss for 6.

After changing over from a circle floor foundry to a straight floor foundry, it took our moulders a good while to get so that they did not have a whole lot of losses.

The new machinery and the new methods, even with our moulders who have been doing nothing but making wheels for 20 years, was too great a change. We tried to have a day's work done by a moulder, under the new conditions, but during the first few months our losses run up as high as five per cent.

I believe we would have better wheels if the men were not required to put up quite so much iron in a day for a day's work.

As to the metal in the wheel, I still believe there is plenty of opportunity to improve in that direction, and that the cast iron wheel is a long ways from having served its purpose.

I saw an article not long ago from a very prominent cast iron wheel maker, one who had always taken the position that all that was required of a wheel was the proper chemical analysis. He made the statement that the time had come, when there ought to be some new blood put into the wheel; that for forty years the wheel had been a remelt of the former wheel and now it was time that we commenced over again and started with some new metal.

Mr. W. E. Symons: Owing to the lateness of the hour and the further reason, that I do not claim to be authority on wheels, I shall not enter into any discussion of this subject, but the old saying that "an on-looker sees more of a game than those who participate in it" is responsible for a thought or two, that has occurred to me in con-

nection with this very important question, and which I would like to leave for the author of the paper to treat on in his closing remarks.

The Cast Iron Wheel Committee of the Master Car Builders' Association is deserving of the greatest credit for its efforts in years gone by, and also at the present time. They have been laboring under disadvantage that the average layman or member does not thoroughly understand or appreciate, and while Mr. Bush has presented the wheel question in a well calculated way to arouse renewed enthusiasm on the subject in general, yet it should not be considered as a criticism of the very able work of the wheel committee and those who have contributed to their efforts. It is easy to criticise; in fact, as a rule, the most pronounced critics on a subject of this kind could not do as well as those whom they criticise.

The wheel question as treated here to-night has involved the question of side bearings and center plates, in the discussion of which the chairman has very liberally allowed a wide range of latitude, and a thought has occurred to me in this connection, which I would ask Mr. Bush if he would kindly touch upon in his closing remarks. I have learned in some manner, I am not able to say exactly through what source, that on a certain road in Ohio, I think the Hocking Valley, they have a special form of rail-head with a wheel flange or throat with contour lines to conform, so as to give a larger area of contact or bearing than is the case with other roads, and that this arrangement in conjunction with a certain type of frictionless side bearings has given a mileage on freight car wheels under a certain number of cars far in excess of anything, which has been quoted from any other lines. Doubtless, Mr. Stiffey, the General Superintendent of Motive Power of these Lines, is the proper officer from which this information should come. I do not think he is here to-night, and I do not know if there is any other officer of the road here, but I am inclined to think Mr. Bush is a director of that road, and I further assume that he is one of the directors who directs, and has a personal knowledge of what is going on, and although it is a matter on which he may not feel authorized to speak upon, I am sure any information coming from him on the subject would be very interesting to us if he is in postion to favor us with the same in his closing remarks.

Mr. F. M. Whyte (N. Y. C. & H. R. R. R.): On page 136 of the January Proceedings Mr. Bush presents a photograph of a wheel after several fractures have been made in the flange; I think that these are typical fractures and that the surface in each case is nearly perpendicular to the direction of the force which caused the fracture; therefore, the metal was in tension. It seems to be quite impossible to strengthen the flange by so arranging the metal that the metal will be in compression, in which direction it resists best, when subjected to such blows. Another method to increase the strength of the flange is to increase the area of the metal; I understand that the committee

on standard wheels have attempted to do this and while they are not satisfied with the results, nevertheless, they think that the results promised justify the additional material. It is probable that this is only a hope.

There remains one way of strengthening the flange and that is by using a material with a greater tensile strength than has the material in the average cast iron wheels. The makers of cast iron wheels say that they can produce wheels amply strong for the service; it would appear to be a wise thing for them to do very promptly if indeed, it is not now too late, because sometime within the next few years a balance will be struck between the two sides of the account, on one side being the first cost of wheels, made of higher grade metal, let us say steel, the cost for machining, etc., if such is done, less the value of the scrap, and the damage resulting from broken wheels, and on the other side being the first cost of the cast iron wheel, the scrap value and the cost for damages resulting from broken wheels. The first cost of steel wheels will decrease and the wheel makers say that the cost of the higher grade cast iron wheel will increase and it can be readily seen that if the higher priced cast iron wheel is to be saddled with the greater damage cost of the lower grade cast iron wheel then the earlier will the difference between the two sides of the account be small enough to justify a decision against the cast iron wheel.

Consider the shape of the tread and flange: I think that the tapered tread is of little value, because it is soon worn to a different form and even while tapered and wheels properly mated may result in a "seeking" which will be very objectionable.

The shape of that side of the flange which is next to the rail should be changed with the utmost caution because there is a relation between the shape of the side of the rail-head, the rail-side of the wheel flange and the minimum wheel load which, if disregarded, may result disastrously.

The question of sharp flanges should be studied deeply; "off-hand" opinions are well enough at times but to this question must be given serious thought and the more attention given to it the deeper it becomes. As President Seley has said, the flanges are put on the wheels for a purpose and to serve their purpose, must be worn more or less. It is possible to make a pair of wheels so exact that they can be rolled in a practical tangent and not need flanges to guide them; it is also possible to make a pair of wheels with the relation of diameters such that the pair can be rolled in the desired curve without being guided by flanges if the centrifugal force is small enough to be disregarded. It is impossible however, to so arrange a pair of wheels that it can be rolled on tangent and any curve without putting flanges on the wheels to guide the pair along such track as the pair is not exactly suited for. Where this guiding must be given is where

the flange wear is done. Because the tangent, a curve with radius of infinite length, makes up a greater portion of the track than does a curve of any other particular radius, we attempt to mate the wheels on axles and in trucks to roll properly on tangent. Therefore, the trucks must be guided on curves and flange wear must result. This may be called normal flange wear and is not the wear which concerns us most unless an excessive amount results from wrong material in the flange. We are concerned most with the unusual amount of flange wear resulting from resistance offered to the truck to take its correct normal position on the track and such resistance is affected by the mating of the wheels on an axle, angularity of axles in a truck, longitudinal displacement of the axles in a truck, the distance between the extreme axles in a truck and, if the super-imposed load is carried upon more than one truck then, the friction between the super-imposed load and the truck. We must not overlook the fact that even the normal work to be done by the flange will vary with the wheel load. Erection work has all to do with the mating of the wheels and the angularity and displacement of the axles; the design has to do with the distance between the extreme axles; and both erection and design have to do with the friction between the truck and a load swivelly imposed. It is not desired to dwell upon the first item relating to erection work. Concerning the second item, the distance between the extreme axles, it may be said that the greater this distance is the lower the curving resistance. Concerning the third item, the friction between the swiveling load and the truck, it may be said that the design has to do with providing the necessary support and at the same time keeping to a minimum the product resulting from multiplying the swiveling friction by the radius through which this friction acts. This product divided by one-half the diagonal dimensions of the truck gives approximately one of the resistances which must be overcome by the flange of the forward outer wheel in swiveling the truck under the load and hence the desirability of making the truck wheel base a maximum. The erection part of this item has to do with so assembling the parts that each integral of the swiveling bearing, centerplate or side bearing, carries its correct portion of the load. Of course it is desirable to keep to a minimum the friction in the swivel bearings, but I think that we have much to learn concerning the relation between the diameter of centerplate and radius of side bearings to total wheel base of truck.

In the discussion of the subject a month ago, reference was made to the effect on flange wear which the amount of clearance between the coupler shank and carry iron might have; I think that the amount of this clearance has no effect on the flange wear. If the truck is free to turn it will go round a curve with the flange of the outer, forward wheel against the rail; if the truck is interlocked with the body by excessive friction, or otherwise, it will go around in that

position and the comparative slight variation in the direction of draft even in such extreme deflection of coupler from center line of car as may result on usual maximum curves will not affect the flange wear.

The horizontal component of the maximum drawbar pull for drawbar displacement on maximum curves for main line is a small amount and what ever it is, only a small part of it, at most, acts on the forward axle parallel to the axle.

Mr. DeVoy: May I ask one question? If there is no horizontal component and the side clearance does not affect it, why does it enter into the discussion of the last speaker? In the remarks a month ago the claim has been made, I mean that that did enter into the conditions. I did not say what per cent, I did not compare it, I did not measure it, but it enters into the fact. I would like to have that explained before the gentleman goes away, as to whether he means that there is such a force or whether there is not. I take it now that there is something.

Mr. F. M. Whyte: With the clearance prescribed by the M. C. B. Standards, and the maximum difference in length of what we may call the standard freight equipment cars, the couplers would not touch the carry irons when the cars are on the usual maximum curves for main line. Therefore under these conditions there would be no component at the carry iron.

Not much clearance is required between coupler and carry iron for cars so nearly the same length as the usual freight equipment cars when the cars are operated on uniform curvature, or uniform curvature with the usual easements, but the clearance is necessary to save carry irons, side lugs and the underframing to which they are attached when the cars are operated on short reverse curves such as turn outs.

Mr. DeVoy: Mr. Chairman, I rise to move a vote of thanks of this Club to Mr. Bush for his able paper. I do not know that "able" quite expresses my opinion, but any paper that can occupy the attention of two entire meetings and has not yet been exhausted, is one which certainly call for a great deal of thanks, and I move you that a vote of thinks be tendered Mr. Bush for his able paper.

Seconded.

The President: I am sure that every member of the Club, either present or absent, will join in the spirit of this motion. The paper is presented by Mr. Bush with a great deal of care, he being entirely disinterested in the matter, as he has stated, and I take pleasure in putting the motion.

Motion carried unanimously.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, March 17, 1908. President C. A. Seley in the chair. The meeting was called to order at 8 p. m. The following members registered:

Albert, C. J.
Alsdorf, R.C.
Arlein, E.J.
Axtell, G.F.
Baker, F.L.
Barber, L.W.
Barnes, C. A.
Bartlett, Hugh
Brown, S. D.
Buckingham, C. L.
Buell, D. C.
Callahan, J. P.
Cameron, F. C.
Carney, J. A.
Christensen, A.
Cline, McGarvey
Cole, H. L.
Cram, T. B.
Crawford, C. G.
Cresse, Roy
Darby, I. W.
De Groot, E. H., Jr.
Delaney, A. G.
Dewar, J. I.
Dewey, L. R.
Dodd, T. L.
Dow, G. N.
Endsley, L. E.
Fantom, W. F.
Fenn, F. D.
Fogg, J. W.
Forsyth, G. H.
Forsyth, Wm.
Fosdick, F. C.
Gale, W. T.
Gardner, J. C.
Gilmore, Frank
Goodwin, G. S.
Goss, W. F. M.
Graves, R. I.
Hahn, F. W.
Haig, M. H.
Hamill, W. H.
Hatt, W. K.
Hayward, O. C.
Heath, Jno.
Henderson, T. D.
Hill, C. P.
Hildreth, F. F.
Hincher, W. W.
Humphreys, C. J.
Hungerford, W. R.
Hunter, P.
Jeffries, B. H.
Jett, E. E.
Kipp, A. W.
Kleeman, Chas.
Kleeman, Chas.
LaRue, H.
Lewis, B. T.
Leppla, A. F.
Lickey, T. G.
McAlpine, A. R.
McClain, H. O.
MacKenzie, D. R.
Manchester, A. E.
Meloy, E. S.
Midgley, S. W.
Monroe, M. S.
Motherwell, J. W.
Ogle, W. F.
Olson, O. M.
Osman, H. L.
Parker, C. S.
Peck, C. L.
Peck, P. H.
Pratt, E. W.
Price, R. C.
Robb, J. M.
Roddy, J. F.
Sargent, Geo. H.
Schmidt, E. C.
Seaberg, F.
Schneider, Aug.
Scofield, W. C.
Seley, C. A.
Seymore, J. B.
Sharp, W. E.
Sherman, L. B.
Slibeck, G. J.
Smith, W. R.
Snead, J. M.
State, R. E.
Storrs, C. P.
Stott, A. J.
Sweringen, F. H.
Symons, W. E.
Taft, R. C.
Tawse, W. G.
Taylor, J. W.
Thomas, C. W.
Thompson, E. B.
Thompson, F. W.
Thurnauer, G.
Walbank, R. T.
Wall, G. L.
Webb, E. W.
Whitridge. J. C.
Whitsel, N. B.
Whittier, C. C.
Willcoxson, W. G.
Williams, I. E.
Winslow, H. L.
Wishart, J. G.
Woods, U. O.
Zealand, T. H.
Zeleny, Frank

The President: The meeting will please come to order.

The first business of the meeting will be the approval of the minutes of the last meeting. These have been printed and distributed and unless objection is made, they will be approved as printed.

The next business is the report of the Secretary.

The Secretary: Mr. President, I have the usual membership statement:

Membership, February, 1908	1,458
New members approved by Board of Directors	19
Total membership	1,477

Name Title Address Proposed by

Eugene McAuliffe, Genl. Fuel Agt. Rock Island Lines, Chicago .... W. E. Symons
R. B. Clark, Scullin-Galagher Iron & Steel Co., Chicago.. E. H. Walker
M. E. Wise, The Railway Age, Chicago.......... E. H. Walker
W. F. Bleecker, Prest. Universal Mfg. Co., Boulder, Colo. J. W. Taylor
G. W. Beebe, Wheel Inspector C. B. & Q. Ry., Aurora, Ill. S. D. Brown
H. U. Morton, V. P. Natl. Mfg. & Supply Co., Chicago... H. H. Shroyer
A. J. Odegaard, Pur. Dept. Rock Island Lines, Chicago.... Carter Blatchford
C. J. Pilliod, G. F. T., St. L. & W. R. R., Frankfort, Ind.. R. J. McGrail
C. W. Clements, Inspector C. B. & Q. Ry., Aurora, Ill.... G. H. Hill
L. A. North, Mach. Shop Foreman Ill. Cent. Ry., Chicago. F. G. Colwell
A. M. Sheffer, Atlantic Equipment Co., Chicago.......... J. H. Wynne
E. B. Reynolds, C. C. to Supt. Tel. Ill. Cent. Ry., Chicago. E. Parsons
H. S. Mored, R. E., C. B. & Q., Ottumwa, Ia.......... I. N. Funk
C. S. Parker, Secy. Parker Car Heating Co., Detroit, Mich. G. H. Bryant
H. A. Johnson, Engr. Car Equipment Met. W. S. Ele. Ry. Chicago .... E. T. Munger
Harry Barnard, Draftsman, Armour & Co., Chicago...... W. E. Sharp.
Roy Cresse, C. C., C. R. I. & P. Ry. Store Dept., Chicago.. C. L. Buckingham
W. C. Scofield, F. B., I. C. R. R., Chicago.......... G. M. Crownover
Hugh Bartlett, Clerk Wabash R. R., Chicago.......... J. E. Gardner

The President: I regret very much that we are somewhat crowded tonight, due to the presence in the banquet hall which we usually occupy of another Association. However, we will do the best we can with the courtesy which is accorded us by the hotel company.

There are two papers this evening, the first to be given by Prof. W. K. Hatt, Professor of Civil Engineering and director Laboratory for Testing Materials, Purdue University, on "Structural Timber." I take great pleasure in introducing Prof. Hatt.

STRUCTURAL TIMBER.

By W. K. Hatt, Civil Engineer, Forest Service, U. S. Department of Agriculture.
Professor Civil Engineering, Purdue University.
Western Railway Club, March, 1908.

SUBJECT DEFINED.

The various aspects of the subject, Structural Timber, cannot be dealt with even in the form of a summary in the lecture hour. It

is not my intention to bring to the consideration of this audience the larger elements of the problem of the supply and use of wood. Those vital matters: such as the uses to the nation of forests; the existing supply of wood and the period of its probable exhaustion; the agencies by which the present supply may be preserved or husbanded, or by which new supplies may be grown under commercial conditions; the distribution and character of our forests; and the trade conditions under which the various producing points are able to hold or extend their markets—these cannot even be sketched in outline. Nor shall I describe the various species of timber, their distribution, lumbering and characteristics, nor discuss the problem of unit stresses.

I shall, however, attempt to discuss the physical character of wood fabric and indicate the effect on its strength of various elements arising during the growth of the tree, and of some of the various operations which are necessary in preparing the material for market.

1. WOOD.

Characteristics of Wood.—Think for a moment of the great number of industries, each one of which demands certain specific mechanical and physical properties of wood, and of the variety of structure and the multiform properties present in the various species of wood from which each industry has been able to select those appropriate to its needs.

The maker of bent wood for shafts, and the like, requires wood that can be steamed and bent without splintering and crinkling. He finds hickory, ash and white oak suitable to his purposes. The finisher desires a soft, fine grained wood that will work easily, shrink uniformly without checking and will take the polish. The cabinet maker seeks beauty of pattern and color. The maker of musical instruments finds resonance and free vibration in spruce. The paper maker finds the necessary long fiber and cell characteristics in spruce and balsam. The cooper finds that the close grained white oak will bend well and will hold liquids without imparting taste to them. The tank builder finds cypress and redwood durable and uniform in texture. The shingler makes use of red cedar since it is durable and will not split when nailed or corrode the nails. The turner finds maple suitable for his purposes. The packing box manufacturer holds cottonwood in favor on account of its lightness and toughness and ability of holding nails without splitting. The packer of goods like biscuit, must have wood like spruce or white pine that will not impart an odor to his goods. The carriage maker or former of axe handles finds in hickory the greatest amount of strength, resilience and toughness to resist shocks. The former of shovel handles finds ash stiff and light. The hub maker finds that rock elm will not check and split in seasoning; the wagon box maker holds poplar as his ideal, and, that becoming too expensive, seeks a wide board, one

that is light, will finish smoothly and keep its shape. The farmer finds durability in catalpa and black locust fence posts. The track man uses the durability of white oak and its resistance to the mechanical wear of rails. The layer of floors finds white oak, maple and longleaf pine wear well. The bridge builder needs light, strong and stiff timber of large size with straight grain and few knots, timber that is durable and hard in order to withstand wear at joints, and finds his ideal in longleaf pine.

Thus, the list might be extended to the telephone linemen, the shipbuilder, the piledriver, the timberer of the mines, the basket-maker, the charcoal-burner, the car-builder, the toy-maker, the furniture manufacturer, the veneer manufacturer. Each one calls upon wood for a portion of its lightness, stiffness, strength, flexibility, elasticity, toughness, cleavability, hardness, softness, freedom from odor, open or close grain, durability, finishing qualities, freedom from checking, freedom from pitch, ability to take glue and fire resistance. Or it may be the size in which the timber is to be found, the amount of sap, the form in which the trunk grows, the straightness of the grain, the ability to withstand alterations of wetness and dryness without change of form, that often renders the particular species more useful than any other.

For the purpose of this lecture wood may be considered as a compound structure made up of cell elements, these varying in size, character and disposition according to the species and condition of the tree. Wood is thus a fabric as cloth or rope is a fabric, built up

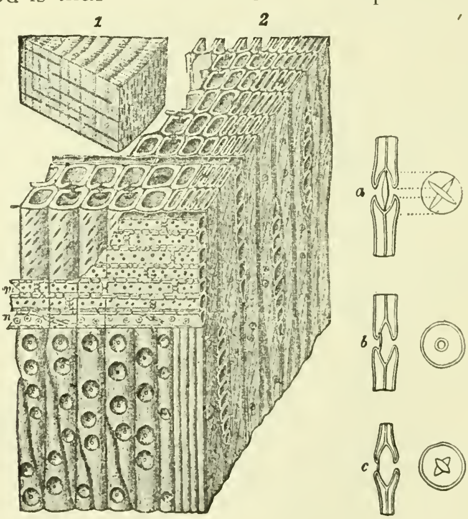


Fig. 1.—Wood of spruce. 1, natural size; 2, small part of one ring magnified 100 times. The vertical tubes are wood fibers, in this case all "tracheids." *m*, medullary or pith ray; *n*, transverse tracheids of pith ray; *a*, *b*, and *c*, bordered pits of the tracheids, more enlarged.

of these cells. Most of them run vertically in a tree and are united at the ends and are interspersed and bound together by radial cells occurring in bundles. The cells communicate with each other by circular openings in the sides, across which a membrane is stretched. Under ordinary conditions in a tree unaffected by decay or chemical action, the strength of the joint between neighboring cells is greater than that of the cells themselves; so that whenever a bundle of fibers of wood is pulled to rupture, the break is due to the tearing of the cell walls and not to the separation of the cells one from another. Or, if subjected to compression along the grain, the cells do not push past each other, but the cell walls themselves buckle. Under a shearing action, directed to separate the cells along their sides in the direction of their length, the cells actually split or tear in two, exposing the interior. This wood fabric has the mechanical properties of strength, elasticity and resilience to a large degree. Wooden springs are used, and wooden horizontal bars known to every gymnast. It has strength varying from the weak white pine to second-growth hickory, which latter, when seasoned, is as strong as steel and more resilient. Wood may be very hard, or it may be easily worked to shape, and it is at present, compared to other structural material, abundant and fairly cheap. Prices are, however, going up rapidly and the advance bids fair to continue.

Anyone who attempts, at the present time, to search the records relating to the strength of timber is led to the very important and thorough work of the committee of the American Railway and Maintenance of Way Association under the chairmanship of Walter Berg, which, at the 5th annual convention at New Orleans, Oct. 1895, made a report on the strength of timber as far as it was at that time known.

This committee found the subject in a chaotic state. The strength of a given species was quoted in hand-books in greatly different values. In some cases the values were found by tests of small clear sticks of thoroughly seasoned timber, and in other cases from tests of large structural timber full of defects, and green.

In many cases the reporter of the tests had neglected to record the description of the material tested. The up-shot of the whole matter was that there was very little certain knowledge of the actual strength of timbers that went into structures, and the degree of variation to be expected, and no information which would enable anyone to determine the relations between the various defects which occur in an element like a bridge stringer, such as knots, shakes, etc., and the strength of that stringer, specifications which were handed down from one engineer to another containing unnecessary and meaningless clauses.

In response to the demand of the public, and as a result of the realization of the fact that there was so little information available to form the basis of answers to the questions that it was called upon to answer, the Forest Service in 1902 took up this matter and began

a new series of timber tests. Then, too, the Forest Service is charged with the administration of large areas of forest in the national forests and it became necessary to study the best uses of the timber being grown in these national forests. Laboratories were established at New Haven, Conn., Washington, D. C., Purdue University, Lafayette, Ind., University of California, Berkeley, Cal., University of Oregon, Eugene, Ore., and University of Washington, Seattle. The work was organized and directed by the speaker. The results of the operation of these laboratories are gradually becoming available.

METHODS OF TEST.

A few views of machines operating on specimens and measuring apparatus attached thereto will serve to illustrate the work of timber tests.

Fig. 2 shows the usual cross-bending test on a minor specimen 2 inches by 2 inches in cross section, selected to exclude defects and to determine the essential strength of the wood fiber. The deflections are obtained from a deflectometer resting on the neutral axis of the beam over the supports, and indicating magnified vertical movements of the center of the beam.

Fig. 3 shows the effect of such a test on a green piece of red gum 4"x4" in cross section. The compression at the top, squeezing out the sap and the tearing of the fiber due to tension at the bottom are well shown.

Fig. 4 shows a cross bending test on a bridge stringer 8"x16" in cross section, loaded at third points. Rollers are placed between the beam and external supports and loads to allow free bending. The failure is due, in this view, to longitudinal shear.

Fig. 5 shows a minor specimen under end compression test, with an Olsen compressometer for recording small deformations to 1/10000 inch.

Fig. 6 shows a railroad tie under side compression test.

Fig. 7 shows impact testing machine. Weight of hammer 50-250 lbs. Height of fall 7 feet. The hammer is lifted by a magnet. A pencil on the hammer records the circumstances of the blow on a revolving drum.

Fig. 8 shows a record from a cross bending test in this impact machine. The deflection, rebound and set are recorded from successive blows of increasing height.

Fig. 9 shows the tool used in making shearing tests.

Fig. 10 shows a torsion test on hickory.

Fig. 11 shows the results of torsion tests of four different grades of hickory. The long brooming fiber of tough second growth hickory is evident.

Fig. 12 shows a special test on a wagon axle in flexure. Loads are applied at the hounds and the axle supported in hubs. Springs are interposed between the axle and support to produce the effect of a dead load.

Fig. 13 shows a bending test of a buggy shaft. The head of the machine bends the shaft and the reaction (or load) on the latter is measured on a spring balance attached to the frame work which holds the shaft.

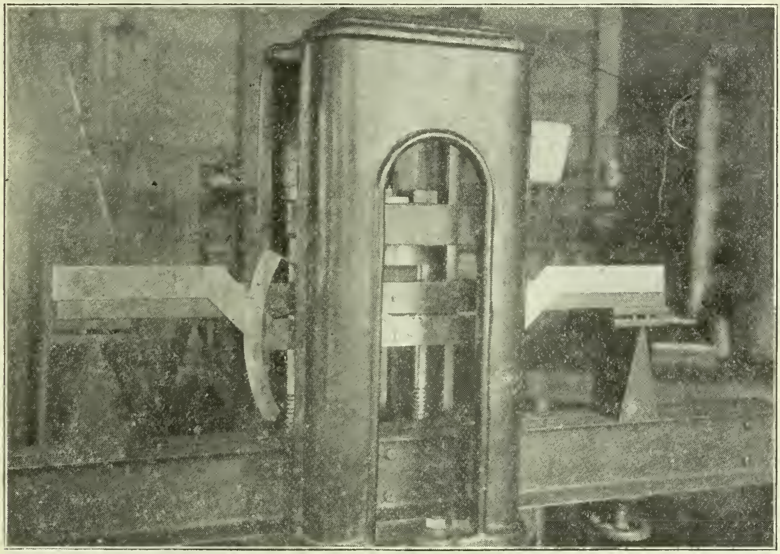


Fig. 2.—Cross bending test on minor specimen.

FACTORS CONTROLLING STRENGTH OF TIMBER.

It is necessary to inquire how wood behaves under stress, and how the strength of wood is affected by such factors as:

Kind of growth—Sap and heart.
  Rate of growth.
Intrinsic defects such as:
  Knots,
  Crooked grain,
  Shakes,
  Seasoning checks,
  Rot, wane, etc.
Speed of loading.
Moisture.
The technological processes of:
  Seasoning,
  Preserving.

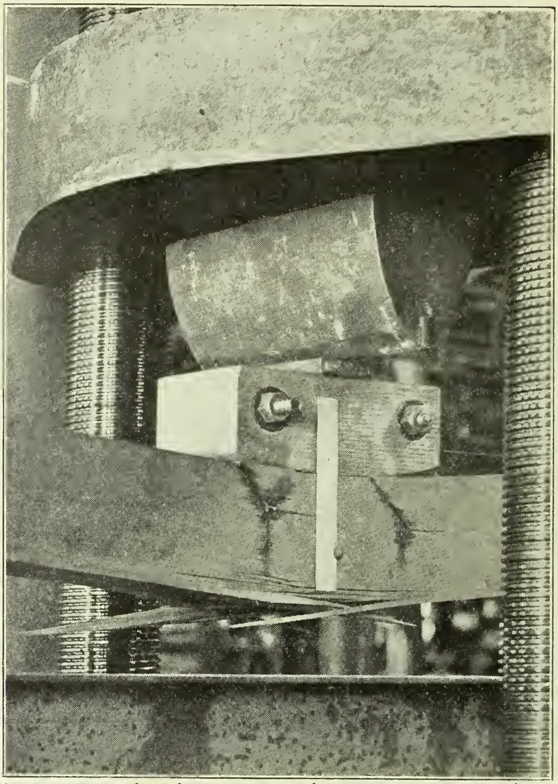


FIG. 3.—Flexure test showing compression at top and tension at bottom.

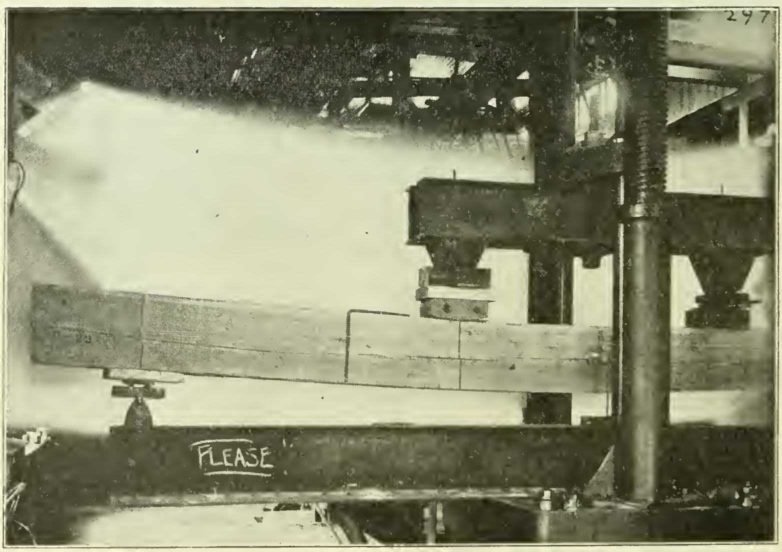


FIG. 4.—Tamarack bridge stringer under test, showing failure in longitudinal shear.

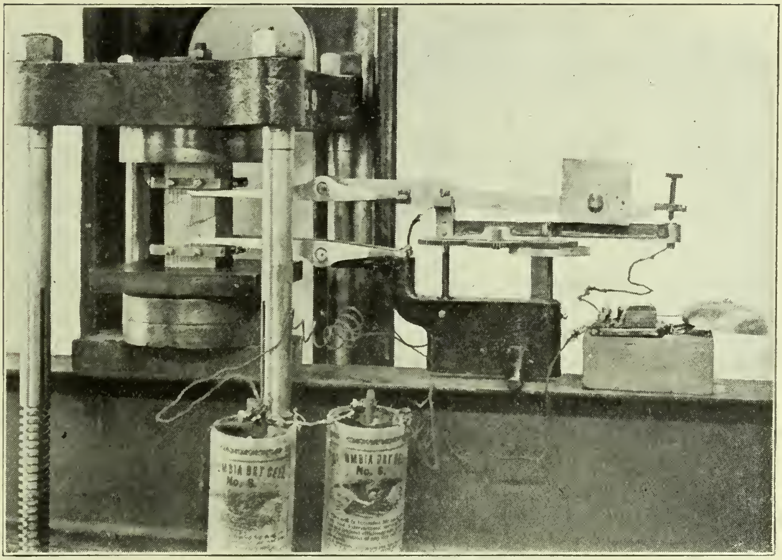


FIG. 5.—Minor test in end compression with Olsen compressometer.

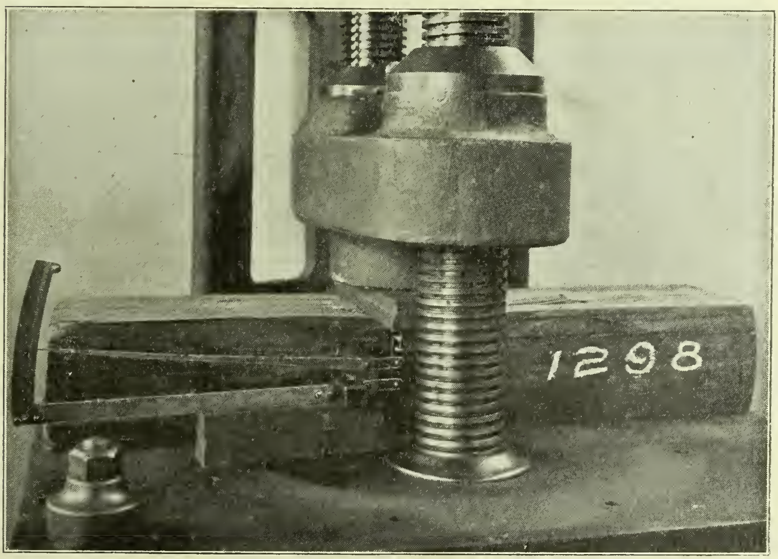


FIG. 6.—Railroad tie under side compression test.

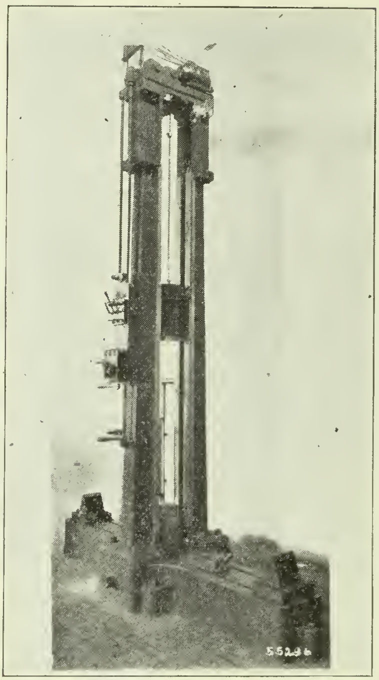


FIG. 7.—Impact Testing Machine.

SAP AND HEART WOOD.

The most obvious distinction between the various parts of a trunk is seen in heart wood and sapwood. The cells of the heart wood are dead and contain no living tissue. The cells of the sapwood contain living tissue, and these cells have stored up in them sugars and starches. It is this food supply in sapwood which attracts the decay-producing fungi, thus, sapwood decays quickly, while the heart wood is more durable. The change of color between heart and sap wood is due to infiltration of various liquids. The sapwood in the growing tree contains from 50 to 100 per cent of moisture, while the heart contains about 20 to 25 per cent. The sapwood dries out more easily and with less detriment to the fabric, and preservatives are more easily injected.

Th sapwood of a yellow pine tree begins to change into heart wood when the tree is about 25 years old, and this change proceeds from the center outward, but does not keep pace with the growth of the young tree. As a rule, the heart wood of a log is stronger and heavier than the sapwood. It must not be inferred that the change from sap to heart has resulted in heavier cell walls or stronger

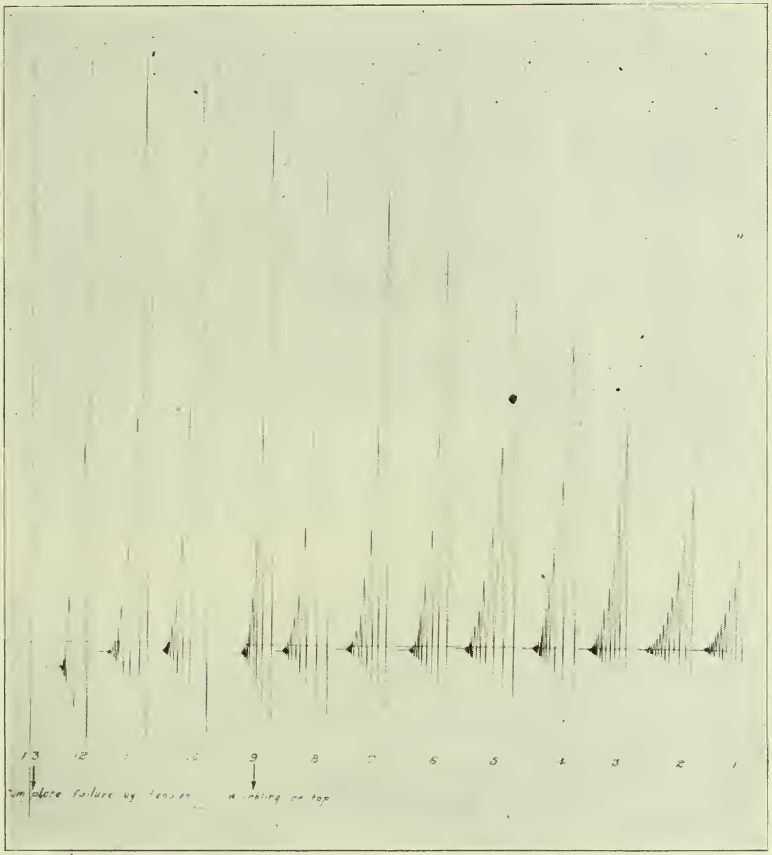


Fig. 8.—Record of bending test from impact testing machine.

wood, or that the heart wood is stronger because it is heart wood. The reason for the greater strength of the heart of this wood is simply because the rings composing the heart were formed when the tree was young and vigorous. The sapwood of a log, which usually represents the growth during the old age of the tree, is weaker and lighter because it was formed in old age and not because it is sapwood.

In Bulletin 95, American Railway Fngineering and Maintenance of Way Association, the writer has presented the analysis of tests on loblolly pine and shortleaf pine beams as follows:

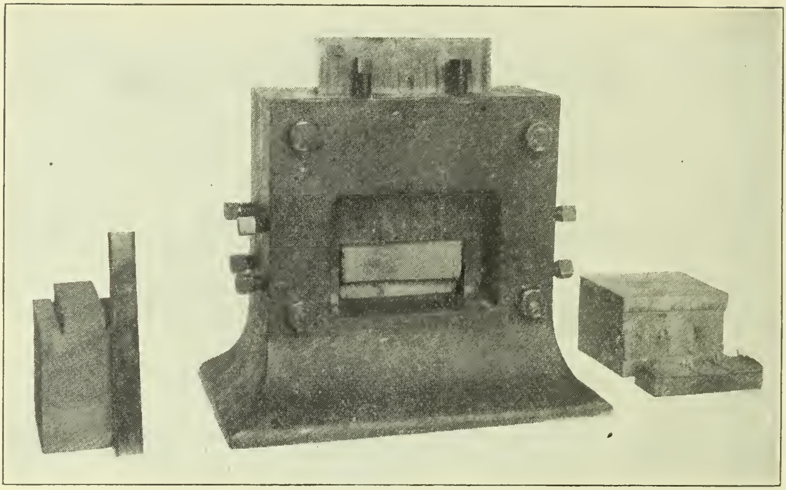


FIG. 9.—Shearing Test.

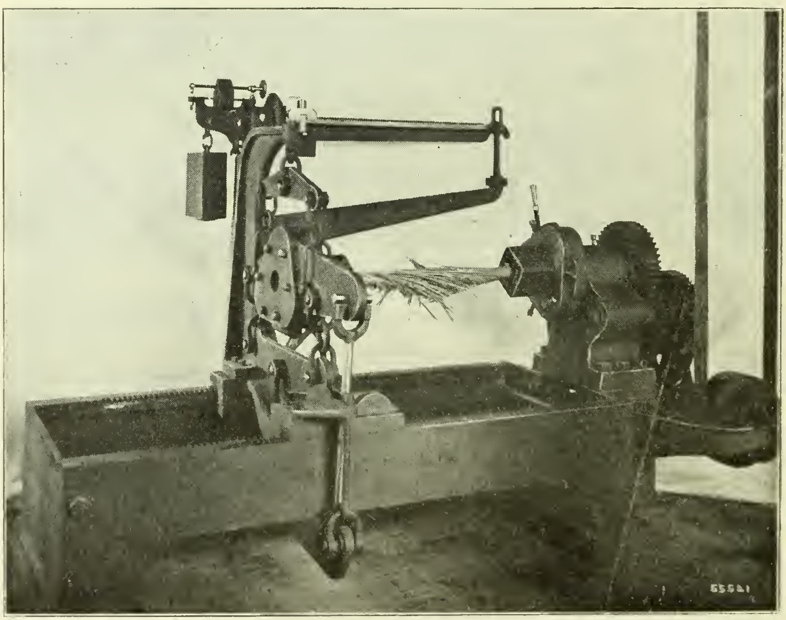


FIG. 10.—Torsion Test on Hickory.

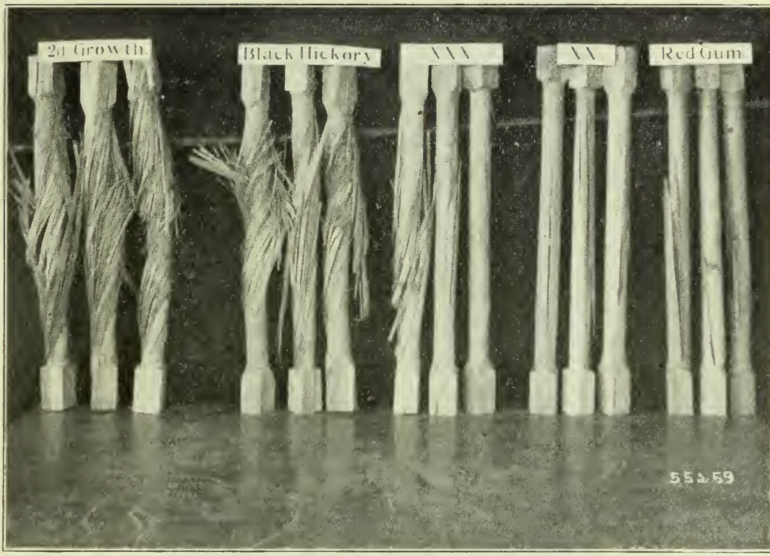


FIG. 11.—Torsion test of Hickory of four different grades, and Red Gum.

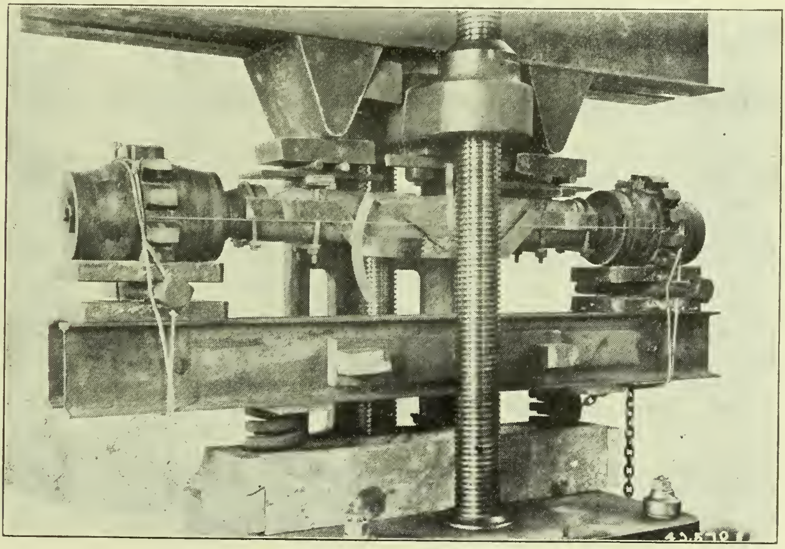


FIG. 12.—Carriage axle under test.

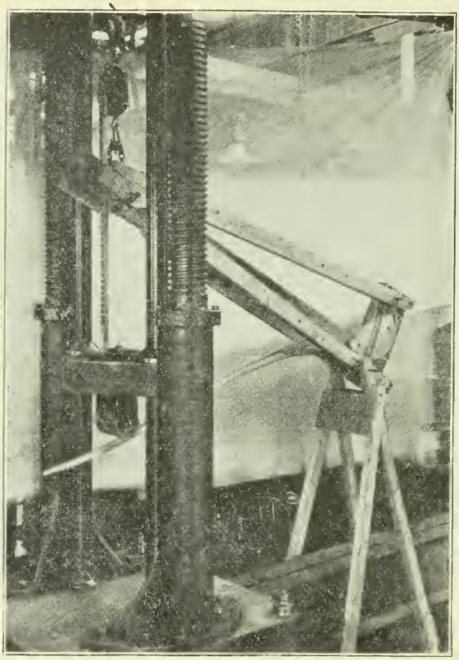


FIG. 13.—Buggy shaft under test.

Table 1. 48 Shortleaf and 42 Loblolly Beams Compared.

LOBLOLLY.			
5 beams with greatest sap..........	86.4	4.96	5926
5 beams with lowest sap............	3.2	7.60	6122
SHORTLEAF.			
5 beams with greatest sap..........	60.0	9.6	5750
5 beams with lowest sap............	0.2	12.2	5742

The beams were from 8"x12" to 8"x16" in cross section and were green. The per cent of sap had litt'e influence in these tests.

COLOR.

An instance of the prevalence of a tradition is in the prejudice against certain colors—the red color of Douglas fir, and the red color of hickory. Trade Bulletin No. 16, Forest Service, states:

The terms red and yellow fir are not thoroughly defined. By some, only close-grained, bright yellow sticks are designated yellow fir and all other sticks called red fir; while others call only close-grained sticks of a pronounced red color red fir and all other material yellow fir. Both red and yellow fir are secured from the same species, Douglas fir, and often from the same tree.

Strength Tests were made by the Forest Service on Douglas fir

bridge stringers. These stringers were graded according to the export grading rules of the Pacific Coast Lumber Manufacturers' Association. The rings per inch indicate that yellow fir is of slower growth than red fir. It also ranges higher in grade. Of the 94 yellow fir stringers tested 47.8 per cent were selects, 40.4 per cent were merchantables, and 11.8 per cent seconds. Of the 162 red fir stringers tested 29.8 per cent were selects, 43.8 per cent were merchantables, and 26.6 per cent seconds, but, grade for grade, these tests show that there is practically no difference in the strength and stiffness of red and yellow fir in bridge stringer sizes.

Likewise in the case of hickory spokes grading rules have thrown red spokes into a lower class. Careful tests, reported in Circular 142, Forest Service, show that red hickory and white hickory should be in the same grade. Figure 14 represents the results of tests on spokes.

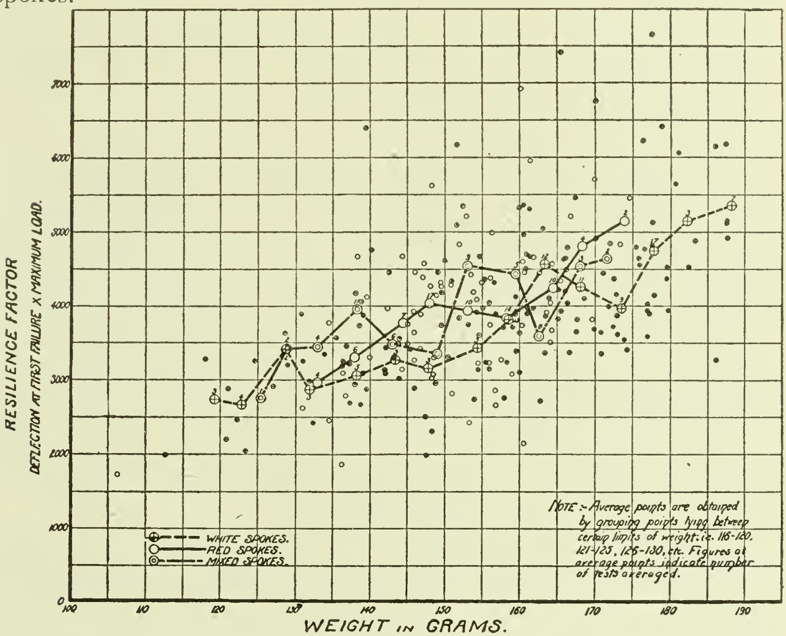


FIG. 14.—Spoke-test chart.

(From Circular 142, Forest Service.)

RATE OF GROWTH.

No general rule can be set up concerning the relation between the rapidity of growth and the resulting strength, because of two rings of equal width, representing an equal rate of growth in a given species of conifer, one ring may be composed very largely of soft,

spring wood and of only a small portion of hard summer wood. Again the gradation between these two, whether sharp or gentle, has an important effect, the gradual change producing the stronger wood in the case of conifer. A general rule, however, in the case of coniferous wood is that the strength and specific gravity increase uniformly with the number of rings per inch until a certain maximum is reached, corresponding to the maturity of vigor of the growth of the tree; and then decreases with increasing fineness of growth when the rings are put on in the old age of the tree. For instance, in the case of red fir, the strength increases as the number of rings per inch increases up to 18, and then the strength decreases. As a rule, the wood of old large trees like redwood is fine grained and brittle. Thus, ash and hickory from the center of old trees is not suitable for baseball bats or carriage stock.

Strength seems to be determined most largely by the amount of summer wood present, and since the weight or specific gravity varies with the amount of this summer wood, we may derive the general rule that the strength of any one species increases almost in direct proportion to the specific gravity of the wood of that species. In a rough way the strength of various species varies directly with their specific gravities; but there are exceptions to this rule. It is the general opinion that fast growing woods must necessarily be weak, but this is not necessarily true, for every one knows that the rapid growth, sapling hickory is the strongest and toughest of our American woods. Again, a rapid growing, second-growth red oak is stronger and tougher than the more slowly growing white oak.

The writer has analyzed results of tests made by the Forest Service on 12 longleaf pine, 81 loblolly pine and 72 shortleaf pine beams, ranging from 5 in.x8 in. to 8 in.x16 in. in cross-section to determine the range in rings per inch. The latter quantity in each case is the average rings per inch for the cross-section of the stick. There may be, of course, a greater range throughout the cross-section of any one stick. Table 2 represents the results of this analysis. It should be noted that the analysis is based on rings per inch, rather than on other functions, such as per cent of sap, modulus of rupture and modulus of elasticity. For instance, 8 sticks of loblolly pine present 10.3 rings per inch. The same sticks present 16½ per cent of sap. These 8 sticks are 10 per cent of the total and are selected to include the highest 8 values of rings per inch. It is not to be understood, however, that the highest 8 values of per cent of sap would yield an average of 16½ per cent. The same reasoning applies to the modulus of rupture and modulus of elasticity, for which values are averaged from the same sticks used in computing the average rings per inch.

Table 2 exhibits the range in rings per inch to be expected, and may be summarized as follows:

Longleaf ranges from 23.6 to 6.6 rings........10 per cent basis.
25.4 to 6.2 rings........single beam.
Loblolly ranges from 10.3 to 2.7 rings........10 per cent basis.
17.2 to 2.5 rings........single beam.
Shortleaf ranges from 19.7 to 7.1 rings........10 per cent basis.
23.0 to 6.0 rings........single beam.
Douglas Fir ranges from 23.8 to 3.1 rings........single beam.

In a general way, the strength decreases as the number of rings per inch decrease.

TABLE 2.—RINGS PER INCH, ETC., OF PINES IN STRUCTURAL SIZES.

5" x 8" UP TO 8" x 16" IN CROSS-SECTION.

[From Bull. 97. Amer. Ry. Eng. & Mtn. Way Ass'n]

-	Rings Per Inch.	Per Cent. of Sap in Cross-Section.	Modulus of Rupture in Lbs. Per Sq. In.	Modulus of Elasticity in 1,000 Lbs. Per Sq. In.	Number Tested.
LONGLEAF.					
Average of All................	13.5	6.0	6,493	1,433	12
Rings { Average 10%, highest..........	23.6	7.5	6,855	1,250	2
Average 10%, lowest............	6.6	12.5	6,270	1,304	2
Maximum, single................	25.4	13.0	7,250	1,310	1
Minimum, single................	6.2	6.0	6,040	1,242	1
LOBLOLLY.					
Average of All................	5.2	45.3	5,191	1,289	81
Rings { Average 10%, highest..........	10.3	16.5	6,065	1,670	8
Average 10%, lowest............	2.7	63.0	3,427	689	8
Maximum, single................	17.2	8.0	6,770	1,262	1
Minimum, single................	2.5	83.0	2,995	357	1
SHORTLEAF.					
Average of All................	11.9	26.8	5,609	1,477	72
Rings { Average 10%, highest..........	19.7	24.0	5,805	1,477	7
Average 10%, lowest............	7.1	33.7	5,294	1,436	7
Maximum, single................	23.0	40.0	5,040	1,272	1
Minimum, single................	6.0	44.0	5,680	1,498	1

KNOTS.

The knots occurring in timber represent branches in the trees. This branch grows and increases in diameter and causes a knot in the sawed timber.

The interference of the growth of a branch with the growth of the trunk distorts the grain of the timber. Trees grown in the open develop large branches and the timber has little commercial value. Trees grown in a forest, on the contrary, develop long trunks and a considerable portion of wood free from knots, or clear, because the lower branches are killed early in the growth of the tree, due to the lack of sunlight. Thus, a large proportion of clear wood can be sawed in the mill for finishing purposes, flooring, etc., before the knots are reached near the pith. As the clear lumber has the greatest value in the market, it is only when the knots begin to develop that the sawyer throws the remainder of the log into such forms as rail-

road ties, building joist and other structural timber. Cuts from the top of the tree are more knotty and lighter, more sappy and less strong than butt cuts.

As a practical matter then in buying structural timber, we must accept knots. It is the service to which the piece is to be subjected, and the state of the market with reference to the supply that determines the number, size and kind of knots to be allowed in the engineer's specifications. In all cases we must remember that timber cannot be made to order like steel or wrought iron or concrete, but it must be accepted in the form that nature and the sawyer produce it. As nature does not produce trees entirely without sap or knots, these must be accepted and allowed for in structural timber.

Knots are classified with reference to their size and character. As regards size, we have the terms pin, small and large; as regards the condition, we have such terms as rotten, bright, sound, tight and loose; as to form, we have such terms as round knots, that is to say, oval or circular in form, and a spike knot, or one sawed in the longitudinal direction. Pin knots are not usually over ½ inch in diameter and tight. Small knots are from ½ to 1½ inches in diameter and tight. Large knots are all greater than 1½ inches in diameter. A sound knot is one solid across its face and as hard as the wood it is in, and will retain its place in the stock. The loose knot is one not firmly held by growth or position. An encased knot is one surrounded wholly or in part by bark or pitch. A pith knot is a small, sound knot with a pith hole not more than ¼ inch in diameter.

The strength of a joist is prejudiced by the presence of a knot, depending mainly upon the position of the knot, and to some extent upon its condition, and upon its size with reference to the cross section of the stick. If a knot is firm and closely knit to the surrounding wood, it is somewhat less harmful than one that is loose or shaky.

If a knot occurs in the central two-thirds of the lower portion of a beam, close enough to turn the grain off, it brings about rupture. A comparatively large knot placed far enough from the edge of the stick to allow the fiber to be continuous when passing, is less weakening than a smaller knot located so as to turn the grain off from the edge when passing it. The nearer a knot is to the neutral plane of the stick, the less it weakens the stick. Indeed, knots close to the neutral plane strengthen beams which otherwise have a tendency to fail in longitudinal shear, because they act as pins to keep the two planes from sliding. Knots in the middle half of the depth of a beam do not bring about rupture.

Knots in the top of a stick are less weakening than those in the bottom. Indeed, it is the common practice of users of timber blocking for temporary purposes, when a wooden beam has failed in the bottom, to turn it upside down and use it again.

As a rough rule, which may be applied to loblolly pine, one may state that a stick of timber with knots in the middle third of the bot-

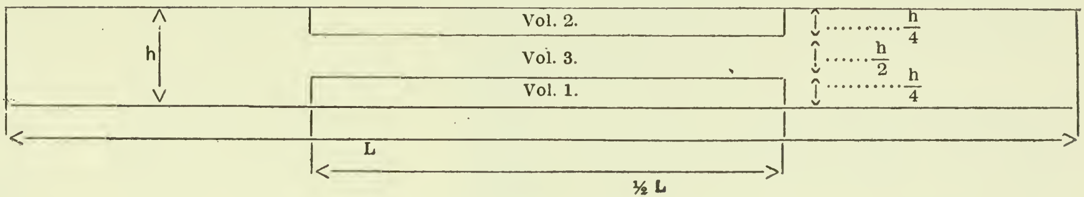
TABLE 3

EFFECT OF KNOTS UPON THE STRENGTH OF LOBLOLLY PINE AND DOUGLAS FIR. SIZE: PINE, 5" x 12"; FIR, 8" x 16"; 15' SPAN

Strength Functions of Groups I and II are Expresssed in Per Cent. of those of Group III.

NOTE.—Shaded Parts of Sketches Indicate Clear Portions of Beams.		Species.	No. of Tests.	Per Cent of Sap.	Per Cent Moisture.	Rings per Inch.	Spec. Grav. (Dry).	Fiber Stress at Elastic Limit. Lbs. per Sq. In.	Modulus of Rupture. Lbs. per Sq. In.	Modulus of Elastictiy. 1,000 Lbs. per Sq. in.
Group III.............		L. Pine D. Fir	11 30	45 0	57 Green	6.5 13.2*	.46	3820 4619	6390 6886	1675 1710
Group II. In Per Cent of Group III.		L. Pine D. Fir	15 30	52 0	75 Green	6.2 12.7*	.48	78.6 93.0	78.6 95.6	82.1 92.1
Group I. In Per Cent. of Group III.		L. Pine D. Fir	33 75	42 0	65 Green	5.6 9.6*	.49	74.1 80.4	71.7 80.2	81.5 84.1

* Approx. (determined on nearly one-half the number of sticks).



Group I.—Sticks having defects in Vol. 1.
Group II.—Sticks having defects in Vol. 2 but not in Vol. 1.
Group III.—Sticks having defects in Vol. 3 but not in Vols. 1 or 2.

tom and in the lower ¼ of the depth has about 70 per cent of the strength of a clear stick; and if the knots occur similarly in the top or compression side, this percentage becomes 80. It is an interesting fact to note that the strength of large sticks is about 75 per cent of the strength of small clear sticks cut therefrom, interesting because it agrees with the determination mentioned above, of the effect of knots in weakening large clear sticks.

The basis of the above statement is found in Circular 115, Forest Service. A series of tests was made on beams cut at a sawmill near Charleston, S. C., for the direct purpose, and on similar beams at Eugene, Oregon. The beams were green. Table 3 contains the digest of the results.

Table 3 shows the method of analysis of the results of the tests in which the beams were divided into three classes, namely: (1) beams having defects in the volume of the tension side projected as one-quarter of the depth from the edge and in the middle half of the length (see Vol. 1, sketch in Table 3); (2) sticks having defects in the compression face similarly located, but no defects in the corresponding area of tension face (see Vol. 2, sketch in Table 3); (3) sticks having no defects in these first two mentioned volumes, but with defects in Vol. 3, or the remaining portion of the stick.

It was found that sticks having knots only in Vol. 3 had practically the strength of clear sticks. The other relations are shown in Table 3 clearly, and lead to the conclusion that sticks of loblolly pine having defects located in Vol. 1 as described have practically 72 per cent of the strength of the clear stick. In the case of green Douglas fir this percentage rises to a value of 80.2, for the reason that green Douglas fir is weak in compression, and that failure generally takes place in clear wood in compression at the top of the beam rather than at a knot in the tension face. In the case of seasoned Douglas fir the relation would probably be different. This remains, however, to be determined.

The following is a general rule for classifying sticks with reference to knots, wavy grain, and other defects. Class 1.—Sticks clear in middle half, one-quarter of height from top and bottom (not necessarily clear in remaining volume). Class 2.—Sticks having defects in middle half, one-quarter of height from top or bottom.

The strength of sticks in class 2 may be taken as 75 per cent of the strength of sticks in class 1.

SHAKES AND CHECKS.

Shakes and season checks operate to divide a beam into two parts and cause it to fail by what is called horizontal shear, that is, split from the end towards the middle, rather than tear apart in tension at the middle. The natural increase of strength according to the square of the depth of a beam is thus lost by division of a beam into two smaller beams.

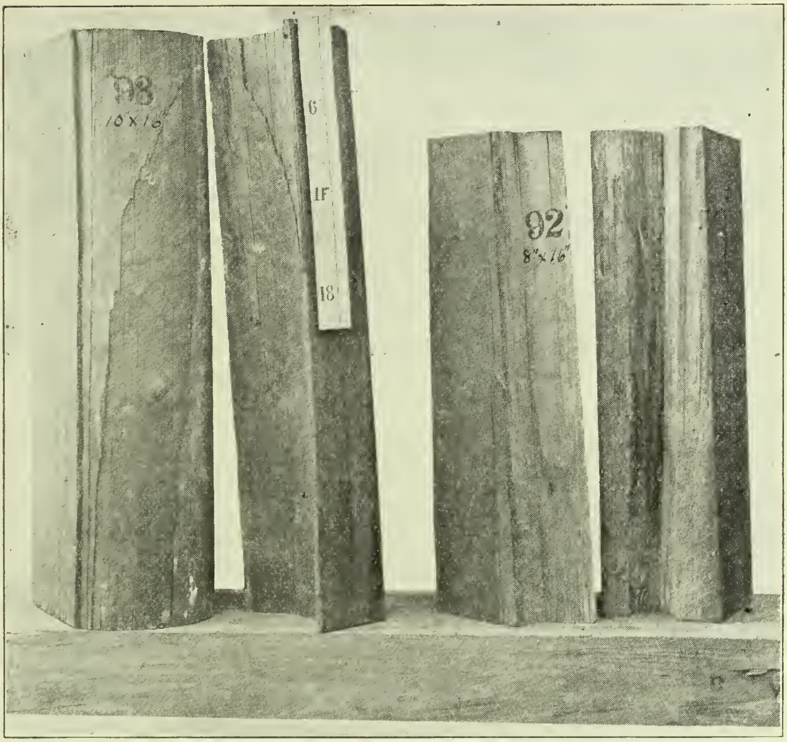


FIG. 15.—Long leaf pine separated by wind shakes.

The most common shake is a ring shake which is a separation of the stick between two annual rings. Fig. 15 exhibits longleaf pine separated by ring shakes. Hemlock is subject to these, and so is longleaf pine when seasoned. These are espcially apt to develop on a boxed heart stick, that is, one sawn with the center of the tree near the center of the cross section of the stick. These are probably due to some weakness of growth of the tree, which fails to supply the proper union between the rings. It is a common belief that they are caused by the action of the wind in swaying the tree from side to side, or, again, to the action of frost. These opinions are probably without adequate foundation.

The tests on merchantable stringers and car sills by the Forest Service indicate that a horizontal shearing stress of 275 pounds per square inch at the neutral axis is likely to result in failure of the beam. The horizontal shear has been as low as 146 pounds per square inch when merchantable sticks have failed in horizontal shear. The actual shearing strength of the wood may be 800 pounds per square inch, but on account of checks or shakes, the effective area is

reduced and the computed resistance to splitting due to horizontal shear in a beam may not exceed 275 pounds per square inch.* Evidently in designing beams the engineer should calculate the existing horizontal shear. A stringer 8x16 inches in cross section and 16 feet long is equally likely to fail by tearing at the center due to bending moment, or by splitting at the ends due to horizontal shear if loaded at the center; but if loaded with a uniform load it should be designed for longitudinal shear.

Seasoning checks are caused by strains arising from unequal drying. Thus the end of a stick will check usually along the medullary rays, or radial fiber, which are generally a plane of weakness. The cross section at the ends tends to become reduced, while the cross section nearer the middle of the length preserves its original section. The outer fibers of the piece of wood are bent in at the ends of the stick. They tend to straighten and so open up these checks. Much the same thing happens along the side of the stick and little checks open, usually along the medullary rays. Very often these medullary rays grow in a spiral direction in the tree, and these little checks run in a direction oblique to the main direction of growth of the fibers. Thus the grain as seen by the sawing of the annual rings is straight, but is cross grain as seen by the season checks along the medullary rays. It is the latter cross grain which throws so much vehicle material to low grade stock.

These season checks seen along on the cross section of the stick along the medullary rays are often called star shakes.

Indeed, cross grain, whether induced by knots or spiral growth, either of the main vertical cells or the medullary rays, is a great source of weakness and properly causes the rejection of material whose service demands strength. Other defects are: Rot, dote, red heart, wane and pitch pockets. Rot and dote (dry rot) and red heart (the incipient decay at the heart of over mature pine) are generally eliminated at the point of manufacture. The amount of wane, that is, is usually controlled by specifications, and will depend upon the needs of the purchaser and the state of the market as regards supply. Pitch pockets, which occur in red fir and weaker woods, are described by length and depth, and as light or open.

SPEED OF LOADING.

The stress which wood will develop before showing signs of failure of elasticity seems to be influenced largely by the speed at which this stress is applied. Indeed the strength of wood under the usual testing process is greater as the speed of the testing machine is increased. The strength at very slow speeds is only 85 per cent of that at high speeds, as is shown in Trade Bulletin No. 10, Forest Service. The modulus of elasticity seems constant at all speeds.

*Trade Bulletin No. 10, Forest Service.

When the load becomes truly static, like books on a library shelf, the deflection generally increases for about 40 days in the case of green loblolly pine, until they are 50 per cent greater than those that accompany equal loads under the ordinary testing process. The modulus of elasticity is correspondingly lowered. Rupture will thus occur under lower stresses, although we have not yet any data to determine what proportion of the ordinary load will break a stick if left on long enough. Thurston has made some determinations which show the factors to be ¾.

When we come to impact tests, there is still further increase of strength; and a small beam will deflect twice as far and carry twice the stress as under static loading before showing signs of failure in elasticity.* The deflection at rupture seems to be the same in both kinds of tests. Thus the cellulose requires time before it yields to a force which acts to produce deformation.

These facts render it easier to understand why large fiber stresses may be allowed in stringers.

Very few experiments have been made to determine the resistance of wood to repeated loadings. Tests in tension by Professor Bovey indicate that successive loadings not exceeding 20 per cent of the ultimate strength in no way injures the material.

EFFECT OF MOISTURE.

The effect of moisture on the strength of timber is greater than that of speed or rate of growth. Green wood contains water, both in the cell walls and in the openings of the cells, but it is only the water in the walls that affects the strength. The water in the openings of the cells may be dried out without affecting the volume or the strength; but when the water begins to leave the cell walls they become stiffer and stronger, and shrinkage of volume occurs. The drier the wood, the greater the increase in strength and stiffness in nearly a straight line relation. Hitherto the nature of this law has been obscured by the results of tests upon test pieces that were not uniformly dry. Small sticks of wood may be kiln-dried and thus tripled in strength as compared with green wood. It also becomes more brittle. Of course, on account of the shrinkage, there is more wood material to the cubic inch of dry wood than in the cubic inch of green wood. But this does not wholly account for the increase in strength. The latter is 300 per cent, whereas the increase in weight of the material is only about 10 per cent. Green wood may be soaked indefinitely in water without loss of strength.

Thus loblolly pine sapwood containing 100 per cent of moisture, that is, as much water by weight as wood material, may be dried to 25 per cent moisture before the strength begins to increase. This 25 per cent moisture may be called the "fiber saturation point," at which point the cell walls are saturated. Any subsequent drying

*See Circular 115, Forest Service.

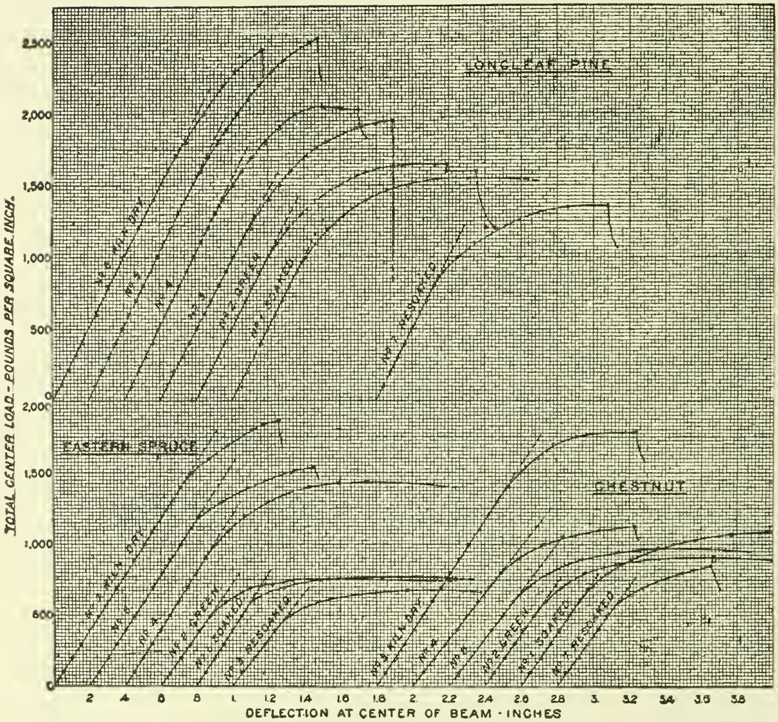


Fig. 16.—Stress-strain diagrams of single series of bending tests.

removes moisture from the cell walls and increases the strength and stiffness of the wood. Thus the moisture strength law is graphically shown by two lines, one horizontal, extending to the right, parallel to the moisture axis, showing no change in strength for increasing moisture, and another slightly curved line sloping up to the left to indicate a rapid increase in strength for any decrease in moisture. The law is usually represented by a single curve, rounding off the junction at the fiber saturation point. However, this incorrect representation is the result of experiments made on wood that was not uniformly dry, i. e., case hardened wood. As will be stated later, the action of steam is to increase the capacity of the cellulose to take up moisture, and so steaming the wood decreases its strength.

Of course, it must be recognized that large sticks cannot be dried to any large extent, indeed, hardly sufficiently to allow this moisture-strength law to operate throughout their entire volume. Moreover, the inequalities of strain, due to the different degrees of drying throughout the volume, set up severe stresses which produce season checks or cracks, or develop ring shakes. So, on account of the operations of these agencies, the engineer is not justified in basing his

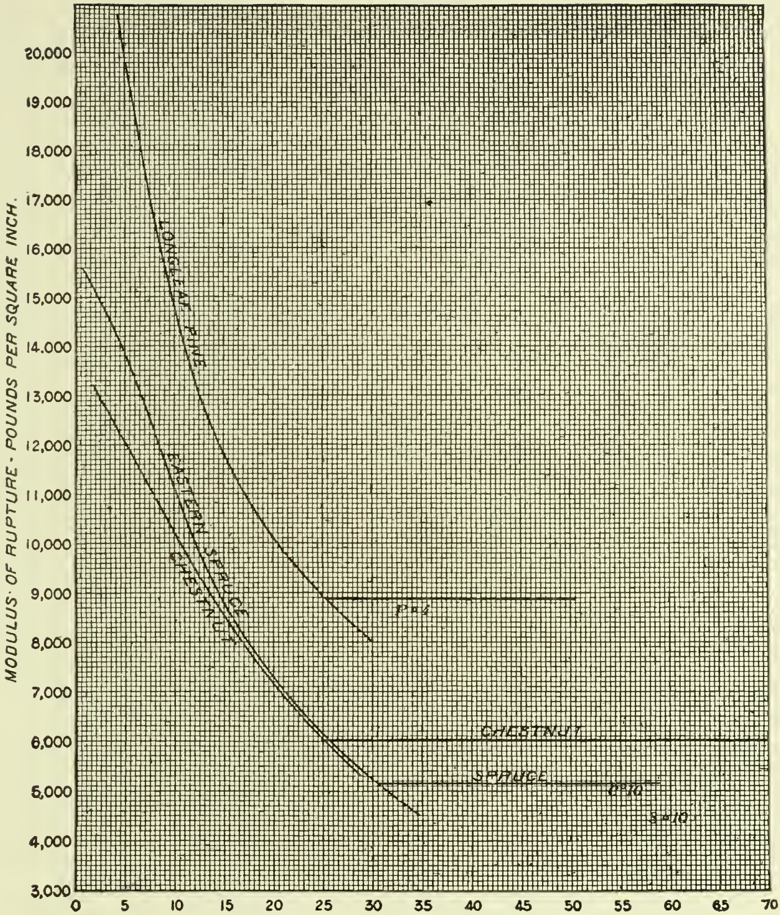


FIG. 17.—Variation in strength with moisture in bending.

unit stress on any other strength than that of the green timber. Sometimes, however, a joist or beam can be built up of 3 or 4 smaller, well seasoned pieces of wood, such as 2x12 planks, and the strength of seasoned wood will be attained. Attempts were made to determine by actual tests on large sticks the relative strength of green timber and timber seasoned under different conditions for priods of time representing commercial conditions.

Table 4 shows the facts as so far developed. In the case of the Douglas fir, the Engineer of Timber Tests operated in conjunction with the sawyer at the mill. In the case of the loblolly pine, the test-

TABLE 4

EFFECT OF SEASONING UPON THE STRENGTH OF LARGE TIMBERS—8" x 16" CROSS-SECTION; 15′ SPAN.

Strength of Seasoned Lumber Expressed in Per Cent. of Green.

SPECIES.	Grade.	How Seasoned.	Per Cent. Moisture (Seasoned).	Cross-Section.	Specific Gravity (Dry).	Fiber Stress at Elastic Limit. Per Cent.	Modulus of Rupture. Per Cent.
Douglas Fir.......	Select	Partially Air Dried	21.8	8" x 16"	.46	127.0	122.2
" "	Merch.	" " "	22.4	"	.43	118.0	111.8
" "	Seconds	" " "	22.2	"	.44	108.0	98.5
W. Hemlock	Select	" " "	25.8	"	.42	113.0	115.0
" "	Merch.	" " "	27.0	"	.42	104.0	106.0
" "	Seconds	" " "	30.0	"	.41	93.0	90.0
Lob. Pine..........	Sq. Edge	Air Dried 3½ Months in Open	23.2	"	.54	105.0	97.0
" "	" "	Kiln Dried 6 Days	20.0	"	.54	139.0	89,5

NUMBER OF TESTS.

Douglas Fir: 135 green; 216 partially air dried.
Western Hemlock: 30 green; 64 partially air dried.
Loblolly Pine: 12 green; 4 air dried; 5 kiln dried.

ing machine was erected in the mill itself. A certain proportion of the cut was laid aside to season and a comparison was made of the strength of green timber and of similar sticks which had been dried. Table 1 expresses the per cent which the strength of the seasoned lumber bore to the strength of the green lumber. The indications are that an increase of strength, due to seasoning, may be expected in the case of the better classes of timber of select grade, but that the defects of structure, such as shakes and checks, which result because of the internal strains arising during the drying process, in the case of merchantable timber and seconds, are likely to offset any benefit due to the drying of the outer portions of the stick. This Table 4 bears out the statement made in the earlier publications, that an engineer is ordinarily not justified in fixing unit stresses for large timbers greater than the strength of green timber.

STEAMING AND PRESERVING.

In the technological operations of bending wood for buggy shafts, wheel felloes, etc., and in seasoning green wood prior to the injection of preservatives, it is common to soak the wood in a steam bath, either exhaust steam at atmospheric pressure, or steam at a pressure up to 40 pounds per square inch. The cellulose is thereby rendered pliable, the sap and food elements are vaporized, but the wood is often rendered brittle or even burnt when the conditions of steaming are too severe. The process of dissociation of the elements of wood begins at low temperature, beyond 212° F., and continues very slowly. A temperature of 280° F., the point of danger, is reached. As a general rule artificial drying is attended with loss of strength as shown under tests under compression, bending, rail bearing and spike pulling, and no process can thus replace the slow air drying under conditions such that introduce severe checks are not introduced.

After the sap is removed from the timber by steam seasoning, followed by a vacuum, the various preservative fluids, such as creosote or zinc chloride, are injected under pressure up to 100 pounds per square inch.

The following statements, published by the writer in Bulletin No. 97, American Railway Engineering and Maintenance of Way Association, resulting from a review of Circular 39, Forest Service, form a fairly consistent account of the elements which govern the strength of creosoted wood in small sizes.

Confining attention to creosoted wood, it seems apparent that any change of strength under treatment will be due either to (a) the preliminary steaming process, or (b) the process of creosoting and presence of creosote.

(a) The effect of steaming upon the strength of the wood depends upon its pressure and duration. The action of either one of these depends upon the kind of wood. A light, open structure, or sapwood, suffers more than a close-grained wood, or heartwood. Seasoned timber suffers more severely than green wood.

Formerly it was thought that the heat of the steam would evaporate the moisture and sap in the cells. It is doubtful if the temperature rises high enough in the tie under ordinary conditions of steaming to effect this evaporation. There is, however, a leaching effect and also a heating of the air in the cells whereby the sap is driven out. Mr. Octave Chanute and Mr. C. G. Crawford have dealt with these matters in addresses before the Memphis meeting of the Wood Preservers' Association.

When steam is applied to the wood and is condensed the fiber takes up more water than that found in green timber. In other words, the fiber-saturation point described above is raised, and just as green timber is weaker than dry timber, so in the same way steamed timber is weaker than green timber. In the case of small pieces, within undetermined limits of steaming, which depend on the condition and kind of wood, the strength may be regained when the wood is redried to its original moisture content. There is, however, a permanent change of structure, for upon resoaking wood that has been steamed and dried the increased fiber-saturation point and weakness again prevails. The steam pressure may be high enough or prolonged so unduly as to scorch the wood, depending upon the quality of the wood and its condition of seasoning. It seems from the generality of evidence in circular 39 that a steaming for 4 hours at 30 pounds pressure, or for 6 hours at 20 pounds pressure, was nearly the limits of safe treatment for loblolly pine ties. Mr. Chanute recommends in the case of fresh cut wood 30 pounds to begin with, and 20 pounds toward the close of the operation.

It is generally admitted that creosote enters only the openings of the cells and does not penetrate or impregnate the cell walls themselves, and for this reason creosote of itslf probably has no effect on the strength of the cell walls. It only acts to retard the seasoning process, and thus creosoted timber will have the strength of green timber if there has been no steaming process, or will have the strength of steamed timber. Indeed in the Rueping process it is possible that the wood becomes seasoned in the cylinder, and thus with a light absorption of oil the timber may be stronger after the process than before. This is not a unique result of the process, but might be accomplished by some other non-steaming process, such as "boiling."

Circular 39 gives in a very complete manner the details of the tests on small pieces of timber tested at St. Louis. It also contains the results of tests upon full-sized loblolly pine ties that had been steamed and subjected to treatment with zinc chloride or with creosote. See Table 5 below. These full-sized ties have been seasoned for about one year after treatment, and the net result of the steaming was to diminish the strength of these ties under the various kinds of tests applied thereto. The creosoted ties represent an abnormal impregnation of 28 pounds of creosote per cubic foot. The modulus of rupture of this timber, which had been steamed at 20 pounds for

TABLE 5.

[From Bull. 97. Amer. Ry. Eng. & Mtn. Way Ass'n]

EFFECT OF STEAMING AND PRESERVATIVE TREATMENTS ON THE STRENGTH OF SEASONED LOBLOLLY PINE

Specimens, Full-sized Ties, Seasoned, Treated, and Reseasoned before Tests.

Treatment.	Cylinder conditions.			Strength (static).				Spike pulling—Force required to pull spike.		Rings per inch.	Weight, air-seasoned.	Reference No.
	Steaming.			Bending.	Compression.							
	Period.	Pressure.	Temperature.	Modulus of rupture.	Parallel to grain.	At right angles to grain.	Average of the three strengths.	Screw.	Common.			
	Hours.	*Lbs. per sq. in.*	° *F.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		*Lbs. per cu. ft.*	
				Untreated wood = 100 p r cent.								
Steam, at various pressures	4	10	237	99.2	79.3	91.1	89.9	118.5	110 7	4.9	38.0	1
	4	20	258	93.7	78.4	99.1	90.4	103.6	109.4	5.2	37.3	2
	4	30	274	87.8	83.4	92.7	88.0	101.1	96.5	5.3	37.9	3
	4	40	286	88.4	78.1	74.6	80.4	93.0	77.9	5.2	37 8	4
	4	50	295	69.1	60.6	74.4	68.0	80.4	70.3	4.8	36.1	5
Steam, for various periods	2	20	257	82.4	81.9	87.1	83.8	97.9	93.7	5.1	38.1	6
	4	20	258	93.7	78.4	99.1	90.4	103.6	109.4	5.2	37.3	7
	6	20	256	87.5	78.8	92.0	86.1	83.0	79.0	4.6	36.7	8
	10	20	256	77.0	75.5	73.2	75.2	84.1	76.8	4.8	36.7	9
Zinc chlorid, 2 5 per cent solution	4	20	258	74.7	65.1	68.6	69.5	75.3	73.8	4.3	41.5	10
Creosote, 28 pounds per cubic foot	4	20	257	69.5	61.2	60.1	63.6	68.2	68.1	4.6	65.3	11

PHYSICAL CHARACTERISTICS AND AVERAGE STRENGTHS OF THE UNTREATED WOOD.

Moisture	per cent (approximate)	20.0
Weight per cubic foot (air-seasoned)	pounds	38.4
Rings per inch		5
Modulus of elasticity	pounds per square inch	1,568,000
Bending strength at elastic limit	do	3,429
Bending strength at rupture	do	6,458
Compression sfrength parallel to grain	do	4,452
Compression strength at right angles to grain (rail bearing)	do	503
Spike pulling—common spike	do	3,598
Spike pulling—screw-spike	do	7,748

4 hours, and then treated with 28 pounds of creosote per cubic foot, and then seasoned for 8 months, was 69½ per cent of the strength of the original seasoned ties. This, in the writer's opinion, shows mainly the effect of the creosote in preventing the natural increase of strength due to the seasoning of the tie. It has been stated above that no substantial increase of strength can be expected when large timbers are seasoned, but railroad ties are not included within this observation.

After having recorded the above observations and relations, the writer concludes that the fiber stresses to be used in the design of trestles constructed of creosoted timber can only be determined with some degree of certainty after a series of tests shall have been conducted on large timbers of bridge material that have been treated by the processes prevailing at present.

Other factors which influence specifications, and which come up in the courts are:

The influence of bleeding longleaf pine trees for turpentine, concerning which I will speak later; the strength and value of timber from trees which have been recently killed by the action of beetles, or by fire; the strength of blued sapwood. Without going into these matters, it may be said that in most cases the clauses in specifications which exclude such lumber from use are unnecessary and shut out good timber with the natural increase in the cost of the work in hand.

In the above paper, the writer has felt free to use material published by himself elsewhere.

For convenience of reference, the following publications of the Forest Service deals with mechanical properties of timber tested.

Bulletin 70. Effect of Moisture on the Strength and Stiffness of Wood.
Circular 32. Progress Report on the Strength of Structural Timber.
Circular 38. Instructions to Engineers of Timber Tests.
Circular 39. Experiments on the Strength of Treated Timber.
Circular 46. Holding Force of Railroad Spikes in Wooden Ties.
Circular 47. Strength of Packing Boxes of Various Woods.
Circular 108. Strength of Wood as Influenced by Moisture.
Circular 115. Second Progress Report on the Strength of Structural Timber.
Circular 142. Tests of Vehicle and Implement Woods.

The President: I believe that this paper is fully up to the standard of the Western Railway Club papers and is a very valuable addition to our literature. It gives us increased respect for the government work in the preservation of forests and investigations of various woods which are used in manufactures of various kinds, and I think that we have to congratulate ourselves on having this paper in our records, backed up by the authority of Prof. Hatt. The paper

is now open for discussion. Will Mr. Crawford open the discussion?

Mr. C. G. Crawford (Chief Office of Wood Preservation, Forest Service, Washington, D. C.):

I do not know that I can offer anything of value as comments on what Dr. Hatt has just said. He has spoken to us tonight on some of the factors which influence the strength of timber.

I have been interested not so much in the strength of structural timber, as I have in a subject which is very closely associated with it, namely: The durability of timber and methods of preserving it. Therefore, I might say a few words regarding some of the factors which influence the durability of timber, if you will pardon this slight digression from Dr. Hatt's paper.

Dr. Hatt has told us that moisture is one of the factors which influence the strength of timber. You are also aware that it is one of the principal factors which influence its durability. You know that if timber is placed underneath water it will not decay, or if it has a slight film of water running over the entire surface it will not decay. If it is placed so that an excessive amount of moisture constantly remains in the timber, the chances of decay are very greatly lessened. If timber is kept perfectly dry it will not decay, or if it contains only a limited amount of moisture the chances of its decay are also greatly lessened. Where there is a slow alternating condition, first wet then dry, the conditions are the best for decay, and these are usually found in checks, small openings, and where timbers are joined together, so that the surfaces are only partially exposed to good drying conditions. Now, why do these conditions so greatly influence the rot of timber? In order to answer this we must know what constitutes rot.

You are probably aware that decay is produced by small organisms belonging mostly to the vegetables kingdom known as fungi; that these fungi grow, produce fruiting bodies and give off innumerable small spores, or little seeds, which are carried by the wind. They frequently lodge on timber and, if the conditions are right, they grow and eventually produce other fruiting bodies, which also give off spores. There are a large number of wood-destroying fungi and they, like other plants, require different conditions for their best growth. Some require very little moisture, and can be easily drowned out just as the larger forms of vegetable life are killed by excessive moisture; while others require a greater amount of moisture and are killed if the conditions are too dry. Therefore, if we are to use methods, which are both efficient and economical, to prevent these different forms of rot, we must first understand the conditions which are necessary to prevent their growth. A requisite amount of moisture is not the only factor necessary for the growth of these fungi. Heat, air and food are also necessary, and in order to understand the durability of timber under different conditions, they must be considered.

The other day I received a letter from a man who expects to build a flume, or a ditch. In the bottom of the ditch he intends to place flooring. The conditions he stated were as follows: There will be from two to four inches of running water for about eight months in the year, while during the other four months the water will be frozen. He wanted to know how long a floor made from one-inch Douglas fir boards would last in the bottom of the ditch, if treated; and how long, if untreated. Also, how long a floor made from two-inch Douglas fir boards would last, if treated. He did not state whether the under sides of the boards would be exposed to the air or not, but, if not, it is my opinion that, regardless of the thickness of the boards, and whether they were treated or untreated, they would remain sound under such conditions almost indefinitely. If exposed to the air on the under side, then possibly a slow rot would take place from that side. A slight knowledge of the causes of decay should help us to better understand the durability of timber when placed under such conditions.

This question of moisture is also a very important one in treating timber with a chemical to preserve it. There are many preservatives advocated today of which it is stated by the promoters that if one or two coats are applied with a brush, the chemical nature of the preservative is such that it will penetrate deeply into the timber regardless of the amount of moisture the wood may contain. It has been my experience that the chemical nature of the preservative has little to do with its power of penetration, but that very much depends upon the amount of moisture the wood contains. When only a slight penetration is secured, the amount of moisture also has much to do with the effectiveness of the preservative. If a chemical, such as dead oil of coal tar, is applied to green timber, it tends to prevent the moisture from escaping, and when a check or opening occurs beyond the zone of penetration sufficient to permit the entrance of a fungus spore, the conditions are just right for it to grow; but if the interior of the timber is dry, the lodging of the spore will probably do no harm. Also, there is much less probability of deep checks occurring in seasoned timber than there is in green; thus, the effectiveness of a preservative is often destroyed by applying it to seasoned timber. In fact, I have some times thought that decay was hastened by applying the preservative to green timber and thus hemming in the moisture; while if it were permitted to escape and the timber thus become seasoned, it would be more durable than the treated green timber. If the preservative is forced by chemical means to a depth so that no check or opening may reach beyond it, then the situation becomes different.

In treating seasoned timber the penetration obtained is not only much greater and more even than in unseasoned, but the preservative tends to keep the moisture out just as in green timber it tends to keep it in. Consequently, there is less checking and less need of such

a deep and costly penetration. So, in the application of chemical preservatives, I think that a consideration of the conditions is very important, if the value of the preservative is to be ascertained as well as the value of the method of application.

I shall not attempt to discuss the effect on decay of heat, air and food, which are the other essential factors for the growth of fungi. You can see that moisture, which is an important factor in determining the strength of timber, is also an important factor in determining its durability.

Professor W. F. M. Goss (University of Illinois): I know that the Western Railway Club needs no argument to convince its members of the value of engineering research, for they have many times asserted themselves on this subject. Nevertheless I can not refrain from calling attention to the fact that the paper this evening illustrated in a very striking way what may be accomplished by systematic, careful attention to a single line of investigation. It has not been many years since the Bureau of Forestry of the Agricultural Department placed this matter of timber testing in the hands of Professor Hatt, but notwithstanding this fact, he has not only devised ways and means of making tests, but he has developed a tremendous volume of very interesting and important information. I think it is due Professor Hatt that emphasis be given this fact.

Mr. A. E. Manchester (C. M. & St. P. Ry.): Mr. President, I would like to have the author of the paper refer to manufacturing methods, as to their influences on the value of the material for a given purpose. It seems to me that it is generally understood that many years ago the timber that we manufactured for the different purposes, especially for building purposes, was much more durable than it is today. I have had rift shingle roofs pointed out to me as having withstood thirty or forty years of service. I call to mind a building that I was quite well acquainted with forty years ago, it was quite a large wooden building. I was looking at the same building a few weeks ago and was told that the same siding was on that building that was on when I knew it forty years ago, and it was then quite an old building when I knew it at that time.

We do know this, that lumber exposed to severe use like, for example, in a car roof, if applied vertically grown will give us from two to three times the life and service that if bastard sawed. It has always been my impression also that much depended on the value of the timber as to the particular time of the year that it was filled and manufactured.

It appears to me that some thoughts along this line might perhaps give us some further insight into that very interesting paper.

The President: Are there any other inquiries that anybody desires to make?

Mr. E. H. DeGroot (C. & E. I. R. R.): Prof. Hatt tells of the effect on the strength of timber of the creosote treatment. I would

be glad if in summing up the discussion he could give us the same information regarding the effect of chloride of zinc.

Mr. William Forsyth (Railway Age): Mr. Manchester referred to an old building that he thought was forty or fifty years old. I was down in Plymouth, Mass., last summer and I saw there some wooden houses that I understand were built in 1690, probably over 200 years old, and I think some of them were never painted and they have never had any preservative of any kind and have been exposed to the moisture of the sea air for that long priod. It would be interesting to know why that lumber does last so long.

The President: If there is nothing further, we will ask Prof. Hatt if he will kindly close the discussion.

Prof. Hatt: The Club will appreciate that what I have been presenting has been along the line of established facts. I have not ventured an opinion and I have gotten so into the habit of working from tests that I have really not any opinion to offer. I think there is no question but that our timber is getting poorer, the wood which we get is poorer than what we used to get, and the good timber has been mainly cut out.

In traveling around the country and talking to users of wood, I have been forcibly struck with the great body of tradition there is concerning the lasting qualities of wood, so that you can hear almost anything you expect to hear.

For instance, the International Harvester Company feel that the long leaf pine which is strong enough, elastic enough for a wagon pole in the South, would not do for a wagon pole in the woods of Minnesota, thinking that the cold, low temperature makes it brittle. Now, there is an opinion which may be and may not be based on facts. As far as I have been able to find out, low temperature has very little effect. There are so many instances of tradition in respect to woods, perhaps the facts are right, but the man's explanation is very often wrong.

I do not know quite what to say with reference to the question as to why it is that the woods that we used to get are lasting longer than those that we get now, except to say that the wood that we get now is poorer than it used to be.

With respect to the effect of treatment of chloride of zinc on timber, I fancy, from what tests I have made, that it has a tendency to induce brittleness, at least the indications are to that effect. It seems strong enough under a static load, but more brittle than timber not so treated under an impact load.

The President: We are also to be favored this evening by another paper to be presented by Prof. Ernest R. Dewsnup, Professor of Railway Administration, University of Illinois, entitled "The Problem of Freight Operation." I take pleasure in calling on Prof. Dewsnup.

Prof. Dewsnup: Mr. President and Gentlemen of the Western

Railway Club—I am afraid I will have to ask you to undertake a process of mental inversion after hearing Prof. Hatt's technical paper upon the subject of timber strength, and I have not dared, as Mr. Seley has suggested in his remarks, to dignify my paper with the title of "Freight Operation." I prefer to call it "Some Aspects of the Problem of Freight Operation."

I ought to apologize right here, for I fear if I do not, that Mr. Taylor will expose me, that this is only a substitute paper; that I promised to the Club a paper upon the Design and Operation of Freight Houses in England and America, but in consequence of being unable to secure the photographic slides in time and thinking that it was not a suitable paper to be handled without the stereopticon, I preferred to defer it and offer a substitute.

I may say that if there is any value attached to this paper, it will not be so much in the paper itself as in the suggestions that it brings out from railroad men, as it deals with one of the problems upon which the public has ventured to exercise an opinion that it is not possible to arrive at without being fully acquainted with the facts.

The paper was then read by Prof. Dewsnup.

The President: I think that we have listened to a very valuable paper in railway economics and it is to be regretted that we did not have the paper in print for distribution for consideration that would lead to intelligent discussion. The hour is rather late and I am of the impression that we could next month possibly devote a portion of the evening to a discussion. However, if there is anybody that has anything to say tonight, we will be glad to enter at once into the discussion. What is your pleasure?

It was moved by Prof. Goss and seconded, that the discussion of this paper be postponed until next month.

Motion carried.

The paper will be printed in the April proceedings together with the discussion.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel, Tuesday evening, April 21, 1908. President C. A. Seley in the chair. The meeting was called to order at 8:30 P. M. The following members registered:

Albert, C. J.	Gale, W. T.	Otley, B. F.
Alsdorf, R. C.	Goodnow, T. H.	Peck, C. L.
Ames, C. F.	Guilford, A. L.	Peck, P. H.
Austin, F. R.	Haig, M. H.	Phipps, D. L.
Averill, T. G.	Henderson, T. D.	Robb, J. M.
Baker, C. M.	Hennessey, J. J.	Rosser, W. W.
Barnard, H.	Hildreth, F. F.	Royal, Geo.
Barnum, M. K.	Hodgkins, E. W.	Ryder, G. E.
Betts, E. E.	Hopkins, G. H.	Schlegell, F. von
Bryant, G. H.	Hubbell, I. C.	Scofield, W. C.
Callahan, J. P.	Jenks, C. D.	Seley, C. A.
Carroll, J. T.	Jett, E. E.	Sharp, W. E.
Cooledge, F. J.	Keeler, Sanford	Sherritt, Frank
Cota, A. J.	Kelley, M. J.	Silk, E. E.
Cotton, W. H.	Kilpatrick, J. B.	Squire, W. C.
Cunningham, J. B.	King, C. H.	State, R. E.
Curtis, J. J.	LaRue, H.	Stimson, O. M.
DeMoss, Ira	Lewis, J. H.	Stott, A. J.
Derby, W. A.	Lickey, T. G.	Taft, R. C.
DeVoy, J. F.	Lowder, R. S.	Tawse, W. G.
Dewey, L. R.	Mackenzie, D. R.	Taylor, E. D.
Dodd, T. L.	Manchester, A. E.	Taylor, J. W.
Dow, G. N.	Meeder, W. R.	Templeton, W. B.
Dunlap, W. L.	Midgley, S. W.	Thompson, E. B.
Eddington, W. J.	Monroe, M. S.	Thompson, J. R.
Estrup, A. A.	Moody, W. O.	Thrall, Jno.
Flavin, J. T.	Morris, T. R.	Willcoxson, W. G.
Forsyth, J. E.	Moskowitz, M.	Winterrowd, W. H.
Forsyth, Wm.	Motherwell, J. W.	Woods, E. S.
Fromm, A. B.	Nathan, C. A.	Wright, Wm.
Fry, C. H.	Neff, J. P.	Zealand, T. H.
	Ostby, O. F.	

THE PRESIDENT: The meeting will please come to order. The first order of business will be the approval of the minutes of the last meeting, which have been printed and distributed. Unless there are errors or corrections to be made, they will stand approved as printed. The report of the Secretary.

THE SECRETARY: Mr. President, I have the usual report of applicants for membership.

Membership, March, 1908	1477
New members approved by Board of Directors	23
Total membership	1500

J. J. Ellis, Insp. & M., C. St. P. M. & O. Ry., St. Paul, Minn.	J. W. Taylor
H. E. Culbertson, M. M., C. B. & Q. R. R., McCook, Neb.	J. W. Chase
C. E. Emerson, Car Foreman, C. B. & Q. R. R., McCook, Neb.	J. W. Chase
A. H. McLean, Air Brake Inspector, Urbana, Ill.	S. J. Kidder
H. B. Ketzle, Natl Dump Car Co., Chicago, Ill.	H. A. Bowen
P. A. Martin, Natl Car Line Co., Chicago, Ill.	M. M. Vincent
T. A. Eselmann, Engr. Dept. Indiana Steel Co., Chicago.	T. B. Cram
Jas. J. Elliott, Sec'y Nashville Carbon & Oil Co., Chicago, Ill.	T. H. Sweringen
Chester N. Stevens, Asst. Mgr. Barrett Mfg. Co., Chicago, Ill.	J. R. Cardwell
L. E. Nelson, Pur. Dept. C. M. & St. P. Ry., Chicago.	Carter Blatchford
E. H. Doherty, M. M., Panama Canal, Corozal, Canal Zone	F. E. Delano
M. T. Lightner, Mech. Dept. C. & A. Ry., Bloomington, Ill.	G. H. Hopkins
F. C. Sorenson, Foreman Armour Car Lines, Chicago, Ill.	W. E. Sharp
Chris. Anderson, G. C. F., C. R. I. & P. Ry., Chicago, Ill.	C. L. Buckingham
J. C. Campbell, Chgo. Pneumatic Tool Co., Chicago, Ill.	C. J. Albert
L. A. Hopkins, Chgo. Pneumatic Tool Co., Chicago, Ill.	C. J. Albert
Frank Sherrett, Imperial Car Cleaner Co., Chicago, Ill.	J. J. Hennessey
W. H. Colton, M. E., Chicago, Ill.	G. H. Bryant
Andrew Speirs, Amer. Car & Fdy. Co., Chicago, Ill.	J. R. Cardwell
W. P. Waugh, Variety Mfg. Co., Chicago, Ill.	C. L. Dinsmore
T. H. Bronson, Engr. C. & W. I. Ry., 83rd St. Shops, Chicago, Ill.	P. H. Peck
W. A. DeMoss, Mach. L. S. & M. S. Ry., Chicago, Ill.	E. D. Taylor
Oscar F. Ostby, Sales Mgr. Commercial Acetyline Co., New York	G. H. Bryant

THE SECRETARY: The membership at the March meeting was 1,477, and these twenty-three additional names make the total membership 1,500. (Applause.)

THE PRESIDENT: The program calls for consideration of the Report of Committee on Revision of Rules of Interchange as the first order of business this evening. This will be followed by discussion of Prof. Dewsnup's paper which was read at the last meeting.

It is the practice in the Master Car Builders' Association to call on the vice-president to take the chair during the discussion on rules, and with such a very good precedent as that, I shall take the liberty of calling on Vice-President Barnum to take the chair this evening.

(Vice-President M. K. Barnum in the chair.)

THE CHAIRMAN: Mr. La Rue, I believe, is chairman of the committee to report on recommendations for changes. Mr. La Rue, will you kindly take a seat near the front? We will want to hear from you frequently perhaps.

Gentlemen, it is the custom of the Master Car Builders' Association, in considering the changes in the rules, to have the Secretary call them by number consecutively and to receive such suggestions as may be offered in addition to those that are made in the report of the committee, and with your approval, we will follow that plan, and when he comes to those rules on which the committee has recommended changes, we will hear from Mr. La Rue, the chairman.

THE SECRETARY: I would like to ask if any members have any suggestions to make as to the preface of the rules. If any members have not a copy of the rules with them, I have a supply at the desk. Rule 2.

MR. LA RUE: It is suggested that the size of return card be given, making the rule read: "In case cars are rejected by the receiving road and returned to the delivering company, all the defects objected to must be designated on a return card 3½ by 8 inches of the following form, placed on the car adjacent to the destination card."

This change was suggested by the leaflet of the Arbitration Committee issued October 1, 1907.

THE CHAIRMAN: We will consider these suggestions in the form of a motion before the meeting, and this suggestion for a change in Rule No. 2 is now open to discussion.

MR. C. A. SELEY: I move that the recommendation of the committee be concurred in.

Motion carried.

THE SECRETARY: Rule 3.

MR. LA RUE: It is suggested that all reference to the brake staff be omitted, making the last sentence read:

"The end of the car * * * toward which the cylinder push rod travels shall be known as the 'B' end and the opposite end be 'A' end."

Moved and seconded that the recommendation of the committee in regard to Rule 3 be adopted. Motion carried.

THE SECRETARY: Rule 4, 5, 6, 7.

MR. LA RUE: Rule 7. Your committee would renew the recommendations made last year, but which were not adopted by the Master Car Builders' Association:

"Shelled out: Wheels with defective treads on account of pieces shelling out; if the spots are over two and one half inches or are so

numerous as to endanger the safety of the wheels on cars of under 80,000 pounds capacity, and two inches on cars of 80,000 pounds capacity and over."

THE CHAIRMAN: You have heard the suggestion for Rule No. 7. Is there any other suggestion? If not, all those in favor of this suggestion say aye.

Motion carried.

THE SECRETARY: Rule 8, 9.

MR. LA RUE: Rule 9. Your committee would again suggest the recommendation made last year as regards the revision of this rule as follows:

"Worn through chill: When the worn spot exceeds 2½ inches in length on wheels of cars under 80,000 pounds capacity and 2 inches on cars of 80,000 pounds capacity and over."

THE CHAIRMAN: You have heard the suggestion for Rule No. 9. Is there any discussion on that? If not, all those in favor say aye.

(Some negative votes were given.)

THE CHAIRMAN: I think we ought to have some discussion. If there are any who desire to speak, we will be glad to hear their points. Mr. Chairman, will you kindly explain the position of the committee in regard to this rule?

MR. LA RUE: I suppose you are all aware of the discussion through some of the railway organizations to shorten the flat spot on the heavy capacity cars. I feel, personally, that two and one half inches under the heavy loads is too large a spot to let go, and it seemed to be the view of the committee this year the same as it was last year. It is up to the Arbitration Committee and the M. C. B. Association.

MR. J. J. HENNESSEY (C. M. & St. P. Ry.): I believe there is a committee that is giving special attention to this subject at the present time,—a committee from the Maintenance of Way Association; I will ask the Secretary if he has had a report from them recently?

THE SECRETARY: No report as yet, Mr. Hennessey.

MR. HENNESSEY: They have given that their special attention for the last six months and they are to have a meeting in the very near future on that subject.

MR. A. E. MANCHESTER (C. M. & St. P. Ry.): In connection with that proposition, recent information furnished to the special committee referred to by Mr. Hennessey brought out this fact, that the change as suggested would increase the number of wheels thrown out on account of the changing from 2½ to 2 about 1,000 per cent, and I do not believe the railroads are well enough equipped to stand any 1,000 per cent addition on that account.

MR. LA RUE: I would like to ask if those figures were not made up on the length of the flat spot being an inch and three quarters instead of two inches?

Mr. Manchester: Yes, it was.

The Chairman: Is there any one else who wishes to speak on this question? If not, all those in favor of adopting the suggestion for a change in Rule 9 as recommended by the committee, will please rise.

A rising vote was taken. The motion was declared carried, by a small majority.

Mr. La Rue: Rule 10. Your committee would suggest that a note be added to this rule, regarding loss of service metal as follows:

"Loss of service metal from steel-tired wheels as a result of sliding to be measured from point where slide begins. One sixteenth inch of metal to be allowed for flat spots under 2½ inches long, and ⅛ inch of metal to be allowed for flat spots 2½ to 3½ inches in length, both inclusive."

The Chairman: All those in favor say aye; contrary no. Carried.

Numbers 11 to 19 were called by the Secretary.

Mr. La Rue: Rule 19. Your committee is of the opinion that the change proposed last year is one that should have been made and therefore suggests that it again be submitted for approval as follows:

"Flat sliding: If the spot caused by sliding is 2½ inches or over on wheels on cars under 80,000 pounds capacity, and 2 inches on wheels on cars of 80,000 pounds capacity or over."

Should the changes proposed in Rule 7, 9 and 19 meet with the approval of the Club, a change should be made in the wheel defect gauge, Fig. 1, page 7, to measure the small size flat spot.

The Chairman: Is there any discussion on this suggestion? This is really dependent on the change in Rule 7 and Rule 9. If there is no further discussion, all those in favor say aye. Contrary, no. Carried.

The Secretary called Numbers 20 to 29.

Mr. La Rue: Rule 29. Your committee would suggest that retaining valves be made an owner's responsibility when found missing, defective or worn out under fair usage, making the rule read as follows:

"Torn air hose, defective, missing or worn out parts of brakes, and retaining valves, not elsewhere provided for, which have failed under fair usage, except missing material on cars offered in interchange."

The Chairman: We are ready for suggestions, gentlemen. Is there any discussion?

Mr. W. E. Sharp (Armour Car Lines): I move an amendment to that by striking out the word "missing." The reason I make that motion is that I do not see how a retaining valve can be missing under fair usage.

The Chairman: The word "missing" is used twice here. Which one do you refer to?

Mr. Sharp: The first one, "missing or worn out parts."

The Chairman: "Missing or worn out parts." That is a motion to amend the suggestion?

Mr. Sharp: It is.

The Chairman: Is there a second? It is not seconded. All those in favor of the suggestion as read, please say aye. Contrary, no. Carried.

Mr. La Rue: Rule 30. It is suggested that the word "marked" be changed to "stenciled," and that the word "reservoir" be added, making the rule read:

"Cylinder or triple valves of air brake cars not cleaned and oiled within twelve months, and the date of last cleaning and oiling stenciled on the brake cylinder reservoir with white paint."

The reason for this suggested change is that there are very many that are not using a stencil and in some cases it looks as if the work had been done with a whitewash brush and in a short time it is obliterated so that the marks are not plain as to the date when it was last cleaned.

The Chairman: A very good suggestion, gentlemen. Is there any discussion? If not, all those in favor say aye. Contrary, no. Carried.

The Secretary: 31, 32.

Mr. La Rue: Rule 32. It has been suggested and meets with the approval of your committee that the ends of train pipe be included in the air brake parts for which the delivering company is responsible, making the rule read:

"Missing air brake hose or missing or broken air brake fittings, ends of train pipe, angle cocks, cut-out cocks, cylinders and reservoirs, triple valves, release valves and pressure retaining valves or parts of any of these items." (Delivering company responsible.)

The reason for this change is that we think that the owner should be protected more fully than at the present time.

The Chairman: Any suggestions? If not, those in favor say aye; contrary, no. Carried.

The Secretary: 33, 34, 35.

Mr. La Rue: Rule 35. It is suggested that inasmuch as the rules which will be revised at the M. C. B. convention in June will become effective September 1st, 1908, that the words "hose on and after September 1st, 1908," be eliminated, making the rule read:

"Cars equipped with air brake hose other than M. C. B. standard (owners responsible), except cars offered in interchange where delivering company is responsible."

The Chairman: You have heard the suggestion, gentlemen. Is there any discussion on this point? If there is no discussion, all those in favor say aye. Contrary, no. Carried.

Mr. La Rue: Rule 36. It has come to the attention of your committee that there are still in interchange service some cars equipped with one inch train line, which should be equipped with M. C. B. standard. To this end your committee would recommend that the above rule be changed to read as follows:

"All cars offered in interchange must be equipped with air brakes. On and after September 1, 1909, M. C. B. standard one and one fourth (1¼) inch train lines shall be used."

It seems there is quite a large number of cars floating around over the country with one inch train line, and if there happen to be one or two of those cars on the front end of a train, it will be almost impossible to get quick action of the brake when necessary.

The Chairman: Can you say about what percentage of cars? Can you give an estimate as to what number this rule would affect?

Mr. La Rue: No, I could not. There is no data on that score, but I do not think it would amount to a very large per cent.

Mr. Hennessey: Do you object to making it more clear by putting in the word "freight" before "cars," because there are a great many passenger cars to which that would apply.

Mr. La Rue: Surely, this is a freight car rule.

Mr. Hennessey:. I know this is a freight car rule, but sometimes it will conflict and we will have a great deal of correspondence over it, and that will make it clear.

Mr. La Rue: Make it read: "All freight cars."

The Chairman: Do you accept the amendment, Mr. Chairman?

Mr. La Rue: Yes.

The Chairman: All those in favor that it stand as amended, say aye. Contrary, no. Carried.

Mr. La Rue: Rule 37. It is suggested that the reference to retaining valves be eliminated inasmuch as it has been suggested that they be included in the provisions of Rule 29.

Owing to the fact that a great many side doors are found to be missing, and when found it is almost impossible to locate to what road they belong, it has been suggested that the question of stenciling the name or initial of road on side doors be referred to the proper committee of the Master Car Builders' Association for consideration.

The Chairman: The first part of this suggestion will be proper for a vote, as I understand it, the other is merely suggestion for separate action. All those in favor of the first part of the suggestion, say aye. Contrary, no. Carried.

The Secretary: That latter suggestion I will take care of by referring it to the proper committee of the Master Car Builders' Association.

The Secretary: 38. 39.

Mr. La Rue:. Rule 39. Your committee would renew the rec-

ommendation made under this rule last year, regarding M. C. B. couplers, making the rule read as follows:

"Steps, ladders, handholds or running boards in bad order or insecurely fastened, absence of grabirons or handholds, *M. C. B. couplers, or their attachments,* as required by law." Balance of rule to remain as at present.

THE CHAIRMAN: You have heard the suggestion, gentlemen. Any discussion? All those in favor, please say aye. Contrary, no. Carried.

MR. LA RUE: Rule 40. There has been so much discussion as to what constitutes an advertisement as covered by Rule 40 and 106, that your committee would suggest that the Western Railway Club recommend to the M. C. B. Association that a paragraph be added to this rule clearly defining what should be considered an advertisement.

THE CHAIRMAN: You have heard the suggestion, gentlemen, any discussion? If not, all those in favor, say aye. Contrary, no. Carried.

THE SECRETARY: 41, 42, 43, 44.

MR. LA RUE: Rule 44. It is suggested that an addition be made to this rule covering the matter of tandem spring pocket attachments when found with single springs, making the rule read:

"Cars equipped with M. C. B. couplers, having pocket rear end attachments and so stenciled, if found with tail-pin attachments instead of pocket; also cars equipped with tandem spring attachment if found with single spring."

You will note that that makes the delivering company responsible for the single spring.

THE CHAIRMAN: All in favor of this suggestion, say aye. Contrary, no. Carried.

MR. LA RUE: Rule 45. Owing to the fact that uncoupling attachments of M. C. B. couplers must be made operative before cars can be moved at all, and to the further fact that they are covered by the suggested change in Rule 39, it is recommended that this rule be eliminated.

THE CHAIRMAN: You have heard the suggestion, any discussion? If not, all those in favor say aye. Contrary, no. Carried.

MR. LA RUE: 46. The proposed change recommended last year is suggested again this year, that is, omitting reference to Rule 45, and adding also uncoupling attachments of M. C. B. couplers, making the rule read:

"Any company making improper repairs is solely responsible to the owners with the exception of the cases provided for in Rule 41, 42, 43 and 44, and also in case it should be necessary to replace spindle with pocket attachment; *also uncoupling attachments of M. C. B. couplers.*

THE CHAIRMAN: You have heard the suggestion; is there any

discussion? If not, all those in favor say aye. Contrary, no. Carried.

THE SECRETARY: The next suggestion is the foot note to Rule 56. Have any members anything to suggest in regard to any rules previous to 56? If not, we will call off Rule 56.

MR. LA RUE: Foot note, Rule 56. It is suggested that the third note be changed to read as follows:

"It will be assumed that a missing coupler and attachments are not damaged." This refers only to cases where the coupler would enter into the combination of defects.

THE CHAIRMAN: You have heard the suggestion. Is there any discussion? All in favor, say aye; contrary, no. Carried.

THE SECRETARY: Have any members anything to suggest before rule 65?

MR. LA RUE: Rule 65. It is suggested that the next to the last sentence be changed to read as follows:

"The splicing of two adjacent sills, except center sills, at the same end of car, or the splicing of any sill between cross-tie timbers will not be allowed, except that one inside intermediate may be spliced when center sills are spliced, providing that such intermediate sill splice is made between bolster and end sill."

This has special reference to an eight-sill car.

THE CHAIRMAN: Gentlemen, you have heard the suggestion. Is there any discussion on this point? If not, all those in favor say aye. Contrary, no. Carried.

MR. SELEY: I would like to ask in what way we are to infer that this has reference to an eight-sill car?

MR. LA RUE: For the simple reason that it says "the inside intermediate" sill.

MR. SELEY: I see, all right.

MR. LA RUE: It very frequently happens that they splice the two center sills and there is no rule against that, but a center sill cannot be spliced between the transom and the end sill.

MR. HENNESSEY: I move that that be amended that it also refer to a six-sill car, for the reason that the two center sills are spliced, they are spliced according to the rule. Take the body bolster, it is often damaged very close to the end sill. Now, the intermediate sill splice between the end sill and body bolster, say within one foot of the body bolster, is just as strong and will answer all practical purposes, as well as if it were in one piece.

THE CHAIRMAN: Gentlemen, this question was voted on, but if there are no objections, we will re-open the question, because we do not wish to shut off discussion, and the object is to have a full discussion on all these questions which are in any doubt, or on which there is any difference of opinion, therefore we will re-open the question, so that it is now before you for further suggestions.

MR. LA RUE: I would not be in favor of splicing the interme-

diate sill in the six-sill car. There is more danger of the inside intermediate in an eight-sill car being damaged on the end and you can splice the one intermediate.

The Chairman: Is there any further discussion, or is it desired to amend the suggestion, or shall we allow it to stand?

It was moved by Mr. Seley, and seconded, that the recommendation of the committee be approved. Motion carried.

Mr. Sharp: Before we leave that rule, I would like to ask the Chairman if they considered splicing center sills at both ends of the car?

Mr. La Rue: Yes, we considered the question of splicing center sills at both ends of the car, but we came to the conclusion that lumber was not quite scarce enough yet and it was hardly fair to the owner of the car to splice the center sills at both ends of the car, it extends your loads between the two transoms on spliced center sills. It was considered and discussed.

The Secretary: The next suggestion of the committee is on rule 75. Has any one any suggestion to make prior to rule 75?

Mr. La Rue: Rule 75. Owing to the fact that a great many roads are not using chains, it is recommended by your committee that this rule be eliminated.

The Chairman: Gentlemen, you have heard the suggestion, is there any discussion? If not, all those in favor, say aye. Contrary, no. Carried.

Mr. La Rue: 76. It is recommended that the suggestions made last year be renewed, adding the words "and state if car repaired is loaded or empty," and also eliminate all reference to the brake staff, making the first paragraph of rule read as follows:

"When repairs of any kind are made to foreign cars a repair card shall be securely attached to the outside face of intermediate sill between cross-tie timbers on wooden cars and on steel cars to cardboard located either on cross-tie under car or on inside of sidesill at the end of car. The card shall specify fully the repairs made and reason for same, the date and place where made, and name of road making the repairs; also show location of parts repaired or renewed, *and state if car is loaded or empty*. The end of car . . . toward which the cylinder push rod travels shall be known as 'B' end, and the opposite end the 'A' end." Balance of rule to remain as at present.

The Chairman: You have heard the suggestion, gentlemen. Is there any discussion? Do you care to make any further explanation of this?

Mr. La Rue: No, just merely changing the rule to conform.

The Chairman: If not, all those in favor, say aye. Contrary, no. Carried.

The Secretary: Has any one any suggestion to make prior to Rule 85?

Mr. La Rue: Rule 85. It is suggested that all reference to brake staff be cut out of this rule, making the last sentence read as follows:

"The end of the car toward which the cylinder push rod travels shall be known as the 'B' end, the opposite end the 'A' end."

This rule is to conform to the changes suggested in the other rule.

The Chairman: Any discussion? If not, all those in favor, say aye. Contrary, no. Carried.

The Secretary: Has any one any changes to suggest before Rule 89?

Mr. La Rue: Rule 89. It is suggested that inasmuch as the M. C. B. Association has three different weights of wheels, that the price given in this rule for 33-inch cast iron wheels should be revised to show prices for wheels of different weights.

The Chairman: You have heard the suggestion, is there any discussion? If not, all those in favor, say aye. Contrary, no. Carried.

The Secretary: Are there any suggestions prior to Rule 92?

Mr. La Rue: Rule 92. It is suggested that the last sentence of this rule be changed to read:

"If no marks are found cast on wheels, or stamped on axles removed, a notation to that effect must be made on the face of the bill."

It has come to the attention of the committee that some companies are insisting on reports of the numbers that are stenciled on wheels and in some cases working hardship on the company removing the wheels, on account of inability to find the number when the other company questions the bill, and for that reason we felt that there ought to be something in the rules, hence the suggestion made that the numbers be cast on the wheels.

The Chairman: You have heard the suggestion, gentlemen, is there any discussion? If not, all those in favor say aye. Contrary, no. Carried.

The Secretary: 93, 94.

Mr. La Rue: 94. It is suggested that the prices in this rule be revised to more nearly conform with present market prices.

The Chairman: You have heard the suggestion; is there any discussion? If not, all those in favor, say aye. Contrary, no. Carried.

The Secretary: Have any of the members anything to suggest before Rule 100?

Mr. La Rue: 100. It is suggested that a new paragraph reading as follows, be added to this rule:

"Malleable backed filled journal bearings shall not be used in repairing foreign cars."

It came to the attention of the committee that there seems to be

objection from many parties in regard to using malleable backed filled journal bearings.

The Chairman: You have heard the suggestion; is there any discussion? If not, those in favor, say aye. Carried.

Mr. La Rue: 106. It is suggested that the item, "American continuous draft rods, one rod, welding, 1 hour," be increased to two hours, inasmuch as it is almost invariably found necessary to straighten the rod, and the allowance of one hour is insufficient.

Your committee would also renew the suggestion of last year regarding draft timbers as follows:

"Draft timber, long, one replaced, 9 hours; draft timber, long, one replaced when its center sill has been replaced, 3 hours; draft timbers, long, two on same end, replaced, 13 hours."

Your committee would recommend additional prices covering Butler draft attachment bolts as follows:

"Butler draft attachment bolts, 2 or less, 2 hours; 3 or more, 3 hours."

Your committee would also suggest that the heading on page 48, regarding repairs of steel cars be changed to read as follows:

"Repairs of Steel or Steel Parts of Composite Cars."

The Chairman: Gentlemen, this is rather a long paragraph, but unless there is some exception taken to it, I think we had better consider it as a whole. If any one wishes to select some part of it, let them mention it and we will take it up separately, otherwise the paragraph as a whole is open for discussion. If there is no discussion, all in favor, please say aye. Contrary, no. Carried.

Mr. La Rue: 117. Your committee would recommend that the item of "worn out parts of brakes as prescribed by Rule 29," be added in the sixteenth line following the figures 22 and 23.

The Chairman: You have heard the suggestion as presented by the committee; is there any discussion on this? If not, all in favor, say aye. Contrary, no. Carried.

The Secretary: Has any member any suggestion as to any of the other rules beyond 117, or to the Passenger Car Rules? The Arbitration Committee would be glad to hear any suggestions that the members have to make.

Mr. La Rue: I have a question in regard to the Passenger Car Rules, which this committee did not take up; that is on page 90, item 60: "Wheels, second hand and scrap steel, $1 per 1/16 inch in thickness of tire, unless tires are loose or broken." What does that mean, the whole thickness of the tire, or just the surface of the metal? I have never been able to get it defined. The tires are run down, some to an inch and some to an inch and an eighth. Now then, if the second hand wheel is an inch and a half, do you measure it to the thickness of the tire, or do you just measure it down to the surface of the metal?

The Chairman: It strikes me that that would be a good ques-

tion to refer to the Arbitration Committee. We have some members of the committee here. I believe Mr. Hennessey is on that committee. Perhaps he could answer your question.

Mr. Hennessey: I am not prepared to answer that question, as the passenger car rules have been always left to and have been practically controlled by the Eastern roads. The Western roads so far have taken very little interest in the passenger car rules, because we do not interchange passenger cars as much as they are doing in the East. Possibly there is a time coming when we will have to do it.

Mr. La Rue: I would like to have that referred to the Arbitration Committee for interpretation. It has come up to me two or three times in regard to wheels, and I am at a loss to know what to do.

The Chairman: Mr. La Rue, I would suggest that you make that as a motion, if you wish to do so, and let the Club take action.

Mr. La Rue: I would move you that the interpretation of that item be referred to the Arbitration Committee.

The Chairman: It is moved and seconded that item 60, page 90 of 1907 Rules of Interchange be referred to the Arbitration Committee for an explanation. Is there any further discussion? If not, all those in favor, say aye. Contrary, no. It is carried.

The Chairman: Gentlemen, I believe I have performed my duties in connection with the revision of the rules and will be pleased to have the President resume the chair.

(Mr. Seley in the chair.)

The President: I think that a vote of thanks of the Club is due to the committee for its report, which is a difficult one to get up, and I would like a vote of appreciation.

Mr. Barnum: Mr. Chairman, I move that the Club express its thanks to the committee for the thorough manner in which they have considered this subject and compliment them upon the results of their work.

Motion seconded by Mr. Hennessey and unanimously carried.

REPORT OF COMMITTEE ON REVISION OF RULES OF INTERCHANGE

Dear Sir:

In accordance with the instructions given at the February meeting your committee submits below certain changes which it thinks desirable in the rules of interchange. It is the opinion of your committee that the rules are generally satisfactory, and the few changes proposed are to make them clearer. Where changes are suggested they refer to the rules effective September 1st, 1907. Where additions have been made in the rules they are shown in italics, and where omissions are suggested they are suggested by the dotted line......................It is hoped the members of the club who are interested in the rules of interchange will study these suggestions carefully, and

come prepared to approve or disapprove as their judgment dictates. If any other changes are thought desirable it is hoped that they will be suggested at the April meeting.

RULE 2, PAGE 3:

It is suggested that the size of return card be given, making the rule read:

"In case cars are rejected by the receiving road and returned to the delivering company, all the defects objected to must be designated on a return card *3½x8 inches* of the following form, placed on the car adjacent to the destination card."

RULE 3, PAGE 3:

It is suggested that all reference to the brake staff be omitted, making the last sentence read:

"The end of the car...........toward which the cylinder push rod travels shall be known as the 'B' end and the opposite end the 'A' end."

RULE 7, PAGE 5:

Your committee would renew the recommendations made last year, but which were not adopted by the Master Car Builders' Assn.:

"Shelled out: wheels with defective treads on account of pieces shelling out; if the spots are over 2½ inches or are so numerous as to endanger the safety of the wheel on cars of under 80,000 pounds capacity, and 2 inches on cars of 80,000 pounds capacity and over."

RULE 9, PAGE 5:

Your committee would again suggest the recommendation made last year as regards the revision of this rule, as follows:

"Worn through chill: when the worn spot exceeds 2½ inches in length on wheels of cars under 80,000 pounds capacity and 2 inches on cars of 80,000 pounds capacity and over."

RULE 10, PAGE 5:

Your committee would suggest that a note be added to this rule regarding loss of service metal as follows:

"Loss of service metal from steel tired wheels as a result of sliding to be measured from point where slide begins. One-sixteenth inch of metal to be allowed for flat spots under 2½ inches long, and one-eight inch of metal to be allowed for flat spots 2½ to 3½ inches in length, both inclusive.

RULE 19, PAGE 7:

Your committee is of the opinion that the change proposed last year is one that should have been made and therefore suggests that it again be submitted for approval as follows:

"Flat sliding: if the spot caused by sliding is 2½ inches or over on wheels on cars under 80,000 pounds capacity, and 2 inches on wheels on cars of 80,000 pounds capacity or over."

Should the changes proposed in rules 7, 9 and 19 meet with the approval of the club, a change should be made in the wheel defect gauge, Figure 1, page 7, to measure the small size flat spot.

RULE 29, PAGE 13:

Your committee would suggest that retaining valves be made on owners

responsibility when found missing, defective or worn out under fair usage, making the rule read as follows:

"Torn air hose, defective, missing or worn out parts of brakes, and *retaining valves,* not elsewhere provided for, which have failed under fair usage, except missing material on cars offered in interchange."

RULE 30, PAGE 13:

It is suggested that the word "marked" be changed to "stenciled," and that the word "reservoir" be added, making the rule read:

"Cylinder or triple valves of air brake cars not cleaned and oiled within twelve months, and the date of last cleaning and oiling *stenciled* on the brake cylinder *reservoir* with white paint."

RULE 32, PAGE 13:

It has been suggested and meets with the approval of your committee that the ends of train pipe be included in the air brake parts for which delivering company is responsible, making the rule read:

"Missing air brake hose or missing or broken air brake fittings, *ends of train pipe,* angle cocks, cut-out cocks, cylinders and reservoirs, triple valves, release valves and pressure retaining valves or parts of any of these items." (Delivering company responsible).

RULE 35, PAGE 14:

It is suggested that inasmuch as the rules which will be revised at the M. C. B. convention in June will become effective September 1st 1908, that the words "hose on and after September 1st, 1908," be eliminated, making the rule read:

"Cars equipped with air brake hose other than M. C. B. standard (owners responsible), except cars offered in interchange where delivering company is responsible."

RULE 36, PAGE 14:

It has come to the attention of your committee that there are still in interchange service some cars equipped with one inch train line, which should be equipped with M. C. B. standard. To this end your committee would recommend that the above rule be changed to read as follows:

"All freight cars offered in interchange must be equipped with air brakes. *On and after September 1, 1909, M. C. B. standard one and one-fourth* (1¼) *inch train line shall be used.*"

RULE 37, PAGE 14:

It is suggested that the reference to retaining valves in this rule be eliminated inasmuch as it has been suggested that they be included in the provisions of rule 29.

Owing to the fact that a great many side doors are found to be missing, and when found it is almost impossible to locate to what road they belong, it has been suggested that the question of stenciling the name or initial of road on side doors be referred to the proper committee of the Master Car Builders' Association for consideration.

RULE 39, PAGE 15:

Your committee would renew the recommendation made under this rule last year, regarding M. C. B. couplers, making the rule read as follows:

"Steps, ladders, handholds or running boards in bad order or insecurely fastened, absence of grabirons or handholds, *M. C. B. couplers or their attachments,* as required by law." Balance of rule to remain as at present.

RULE 40, PAGE 15:

There has been so much discussion as to what constitutes an advertisement as covered by rules 40 and 106, that your committee would suggest that the Western Railway Club recommend to the M. C. B. Association that a paragraph be added to this rule clearly defining what should be considered an advertisement.

RULE 44, PAGE 15:

It is suggested that an addition be made to this rule covering the matter of tandem spring pocket attachments when found with single springs, making the rule read:

"Cars equipped with M. C. B. couplers having pocket rear end attachments and so stenciled, if found with tail-pin attachments instead of pocket; *also cars equipped with tandem spring attachments if found with single spring.*"

RULE 45, PAGE 15:

Owing to the fact that uncoupling attachments of M. C. B. couplers must be made operative before cars can be moved at all, and to the further fact that they are covered by the suggested change in rule 39, it is recommended that this rule be eliminated.

RULE 46, PAGE 15-16:

The proposed change recommended last year is suggested again this year, that is, omitting reference to rule 45, and adding also uncoupling attachments of M. C. B. couplers, making the rule read:

"Any company making improper repairs is solely responsible to the owners wit the exception of the cases provided for in rules 31, 42, 43 and 44, and also in case it should be necessary to replace spindle with pocket attachment; *also uncoupling attachments of M. C. B. couplers.*"

FOOT NOTE, RULE 56:

It is suggested that the third note be changed to read as follows:

"It will be assumed that a missing coupler and attachments are *not* damaged. This refers only to cases where the coupler would enter into the combination of defects."

RULE 65, PAGE 22:

It is suggested that the next to the last sentence be changed to read as follows:

"The splicing of two adjacent sills, except center sills, at the same end of car, or the splicing of any sill between cross-tie timbers will not be allowed, *except that one inside intermediate may be spliced when center sills are spliced, providing that such intermediate sill splice is made between bolster and end sill.*"

RULE 75, PAGE 25:

Owing to the fact that a great many roads are not using chains it is recommended by your committee that this rule be eliminated.

RULE 76, PAGES 25-26:

It is recommended that the suggestions made last year be renewed, adding the words "and state if car repaired is loaded or empty," and also eliminating all reference to the brake staff, making the first paragraph of rule read as follows:

"When repairs of any kind are made to foreign cars a repair card shall be securely attached to the outside face of intermediate sill between cross-tie timbers on wooden cars and on steel cars to cardboard located either on cross-tie under car or on inside of sidesill at the end of car. The card shall specify fully the repairs made and reason for same, the date and place where made, and name of road making the repairs; also show location of parts repaired or renewed, *and state if car is loaded or empty*. The end of car ....toward which the cylinder push rod travels shall be known as the 'B' end, and the opposite the 'A' end." Balance of rule to remain as at present.

RULE 85, PAGE 29:

It is suggested that all reference to brake staff be cut out of this rule, making the last sentence read as follows:

"The end of the car toward which the cylinder push rod travels shall be known as the 'B' end the opposite end the 'A" end.

RULE 89, PAGE 35:

It is suggested that inasmuch as the M. C. B. Association has three different weights of wheels that the prices given in this rule for 33 inch cast iron wheels should be revised to show prices for wheels of different weights.

RULE 92, PAGE 36:

It is suggested that the last sentence of this rule be changed to read:

"If no marks are found *cast* on wheels or *stamped* on axles removed, a notation to that effect must be made on the face of bill."

RULE 94, PAGES 36-39:

It is suggested that the prices in this rule be revised to more nearly conform with present market prices.

RULE 100, PAGE 41:

It is suggested that a new paragraph reading as follows, be added to this rule:

"Malleable backed filled journal bearings shall not be used in repairing foreign cars."

RULE 106, PAGES 42-48:

It is suggested that the item "American continuous draft rods, one rod, welding, 1 hour" be increased to *2 hours* inasmuch as it is almost invariably found necessary to straighten the rod, and the allowance of one hour is insufficient.

"Your committee would also renew the suggestion of last year regarding draft timbers as follows:

"Draft timber, long, one replaced, 9 hours; Draft timber, long, one replaced when its center sill has been replaced, 3 hours; Draft timbers, long, two on same end replaced, 13 hours."

"Your committee would recommend additional prices covering Butler draft attachment bolts as follows:

"Butler draft attachment bolts, 2 or less, 2 hours; 3 or more, 3 hours."

Your committee would also suggest that the heading on page 48, regarding repairs of steel cars be changed to read as follows:

"Repairs of Steel or Steel Parts of Composite Cars."

RULE 117, PAGE 60:

Your committee would recommend that the item of *"worn out parts of brakes as prescribed by Rule 29"* be added in the sixteenth line following the figures 22 and 23.

Respectfully submitted,

H. LA RUE, *Chairman,*
T. H. GOODNOW,
O. M. STIMSON,
J. W. FOGG,
H. H. HARVEY,
Committee.

THE PRESIDENT: We had the pleasure last month of listening to a paper on "Freight Car Efficiency," by Prof. Dewsnup of the University of Illinois, and while it will hardly be necessary to entirely re-read this paper as a means of exciting discussion, I believe it would be well if the Professor would give a short resume of the particular points prior to taking up the discussion. Could you do that, Prof. Dewsnup?

PROF. DEWSNUP: It is somewhat embarrassing, Mr. Chairman and gentlemen of the Western Railway Club, to attempt to reintroduce a subject upon which something has already been said. I do not know that I have in mind a sufficiently concise resume of the subject to place it before you in a few minutes and do not wish to take up the time available for discussion, but, in connection with the paper, I may say that my attention was attracted to freight car performance by repeated charges made by one person and another that the railways of the country had failed to increase their equipment in proportion to the industrial and commercial needs of the country, a statement that has been made in a vague form in many papers and by several speakers.

On investigation, taking the most recent period for which general figures were available, I have found that the ton mileage increase of business from 1900 to 1906 over the country at large was 52½ per cent, while the increase in the number of revenue freight cars was only 34½ per cent. It is obviously unfair, however, to omit consideration of the increased capacity of cars. When this is taken into acccount, the increased car accommodation reaches 61½ per cent as against the 52½ per cent increase of business.

It is not likely, however, due regard being had to existing conditions of marketing in 1900, that the whole of that increase in car capacity was actually capable of being made use of by the shipper. The statistics, however, would seem to indicate that use was made of the extra car space to a considerable extent, since we find an in-

crease of about 20 per cent in car capacity during the period, accompanied by an increase of 17 per cent in average load, so that the deduction to be made from the 61½ per cent increase of total car accommodation would not be likely to reduce the per cent of increase of effective accommodation below the 52½ per cent increase of business. The conclusion inevitably follows, I think, from these facts that, in view of the enormous increase of traffic, the railroads during the period did exceptionally well in keeping the effective capacity of their equipment level and probably more than level with the increase of business.

Further, applying this method of comparison to a limited number of roads covering rather more than one half the business of the country, and extending it over a longer period, namely, from 1897 to 1907, I find that on these 31 roads the ton mileage increased 156½ per cent; that the number of cars increased 97.8 per cent, but that when the car capacity is taken into account, the increase of car accommodation is represented by 198 per cent as against the 156½ per cent increase of ton mileage, this bearing out, of course, the conclusion regarding general conditions as to the country at large. As regards the utilization of the increased capacity, I find that the average load in 1897 over those roads was 13.4 tons and in 1907, 19 tons, representing an increase of average load of 41.8 per cent. The increased capacity, by the way, being from 32½ to 33.9 tons, or 50.7 per cent, this again apparently evidencing a fair utilization of the extra capacity by the shipper in the marketing of his goods.

In further discussion, I referred to the general problem of per diem, and the utility of such a charge but will not now go into detail on that matter. In concluding the paper I made reference to another point in connection with car efficiency, viz., it being established that the railroads have efficiently performed their duties in keeping the equipment accommodation level with the apparent traffic needs of the country, have they been equally efficient in securing improvements along the line of car mileage performance? This is a more debatable question undoubtedly.

Unfortunately, in endeavoring to secure figures over the country at large, or over a considerable number of roads, the difficulty presents itself that the only statistics accessible are those giving number of cars owned by railways at the end of the fiscal year, instead of the average number of cars so owned throughout the year, and total car mileage including but not distinguishing private car mileage. Those facts, of course, affect any average arrived at in the customary way of dividing the total car mileage by the number of cars owned at the end of the fiscal year. Such an average taken for the period 1900-06 shows a decrease of individual car mileage. And even after allowance is made for the difference in the proportion between the number of cars owned at the end of the fiscal year and

the average number of cars and for the private cars, and furthermore for the difference in the composition of the tonnage (the larger proportion of mineral traffic at the close as compared with the beginning of the period), it would seem as though at the best, this apparent decrease could be reduced, but not substituted by an increase, so that, so far as I can see,—and a great deal of light can be thrown upon the matter by the car men connected with the different roads—over the country at large there was, from 1900 to 1906, no improvement in car mileage. It is more difficult to draw conclusions from the statistics of the limited number of roads included in the addendum to the paper, but the evidence seems to point in the same direction. In this case, the mileage per car owned at the end of the fiscal year shows a decrease of about 9½ per cent. It must be understood in trying to account statistically for this decrease, that the percentage of decrease can be affected only by changes in the proportions of private cars to railway owned cars, of cars owned at the end of fiscal year to cars owned throughout the year and so forth. For instance, if it should have happened that the number of private cars had increased so that they bore the same ratio to railway cars in 1907 as in 1897, the percentage of decrease, calculated on the basis of railway owned cars, would not be affected. The same would be true of the tonnage, if the proportion of coal and other car delaying traffic remained unchanged. It is questionable whether in the case of some roads, showing large percentages of decrease in individual car mileage, there has been sufficient change along these lines to account statistically for the whole of the decrease.

Now, I do not come here with the idea of teaching you in this matter of car mileage. The subject appealed to me as a suitable one for a paper because I expected, in presenting it, to obtain a great deal more light upon it than I enjoy at the present time. If this matter could be placed in its proper light before the public, through the medium of this discussion, a great deal of good will have been done.

The President: I feel very much indebted to the Professor for his luminous resume of this paper. I must confess that had he not been present, I could not have done it in anywhere near the same manner. I feel that the Club is under a considerable debt of gratitude for this paper. It is a contribution to economics which has been very interesting to me and I believe to operating and executive officers to even a greater extent. I regret that the meeting of the American Railway Association in New York at the present time has taken a good many of our people away that might otherwise have been present, possibly, to have assisted in the discussion. The paper is as follows:—

FREIGHT CAR EFFICIENCY.

By Prof. E. R. Dewsnup

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Of all the general problems of railway transportation there is none more important, more intricate of solution than that connected with freight service. The efficient performance of this service by the railways has become absolutely necessary to the economic progress of the community; no mean part of the social superstructure of the modern state rests upon it. Hence there emanates from the public a peremptory demand that this function of the railroad corporation shall be discharged with the maximum of efficiency. Inadequacy of organization or incapacity of management affects not only the revenues of the transportation companies, but the general weal of the state. It is claimed even, and not without effective argument, that the economic and social loss to the state through such inefficiency, absolute or relative, is infinitely greater than the loss to the transportation companies, severe though that may be. As to how far, in theory, this may be considered to justify the intervention of the state may well be left for discussion by the theorists with just the note that, even theoretically, the moral justification of such interference must rest entirely upon the presence of fairly conclusive evidence that the state, by its intervention, can improve the situation, with due regard to both present and ultimate results. In practice, however, the public is not apt to wait for moral justification, and unsatisfactory management leads to a discontent and agitation which frequently crystallize into restrictive legislation of a more or less severe type. Aside from the matter of earnings, it is then to the interest of railroad management to discharge the functions, for which it is responsible, as adequately as possible. Supreme in importance among these functions as the freight service is, public attention and criticism have naturally been directed to the manner of its discharge in a greater degree than to any other aspect of railroad performance. The public demands for the members of its community (a) equality of treatment, and (b) a service characterized by adequacy, expedition and economy. The problem of the handling of the freight service is obviously, therefore, very complex; in fact, it is a series of problems rather than a single one. The limits of this paper forbid any exhaustive treatment of the whole subject, and I intend to restrict myself very largely to a consideration of the more general features of freight car efficiency, noticing the extent to which the railways have adjusted their equipment and its handling to the gigantic industrial development of recent years.

The general prosperity has been reflected, of course, in the growth of railroad business, which has been positively astonishing. The rail-

roads of the United States probably handled, during the year ending June 30th, 1907, in the neighborhood of 1800 million tons of freight. The freight handled by the whole of the railroads of teeming Europe can hardly have much exceeded 1500 million tons. Physical conditions, and political prejudices and fears have co-operated in keeping at a low level the average haul in Europe, and, consequently, the more favorable environment here has placed the ton-mileage—the true measure of the freight service of a country—out of all comparison with that of the older continent. During the years named, the ton mileage of the United States probably amounted to 230 or 235 billions, against which, Europe, so far as can be estimated, could not present more than about 100 billions. It goes without saying that enormous difficulties have to be met and overcome in order to administer successfully so huge a mass of business, diffused over a territory of more than three million square miles. But the real extent of these difficulties is not realized until it is comprehended that; during less than a generation, specifically, since 1880, the ton mileage of this country has not merely doubled or trebled but actually septupled itself, an increase of more than 600 per cent. Under these circumstances, it would not be surprising to find the railroads experiencing difficulty in meeting the ever-increasing demands being made upon them, nor would it necessarily be discreditable to them that, in shaping their organization to the changing conditions, there resulted considerable friction of adjustment. Accordingly, the existence of shippers' complaints with reference to car supply, founded though they may be on facts, should not be regarded, in itself, as conclusive evidence of culpable negligence on the part of the managers of railroad transportation. Even without any special general development from year to year, every business has difficulties during the busiest season of each year, in properly meeting the demands made upon the resources of its organization. In arguing thus, there is no desire on the part of the writer of the paper to justify the railroads in carelessness of management, whenever such exists, but his object is to deprecate the measurement of railroad performance by an impracticable standard, which the critics themselves would not consent to apply to their own business undertakings.

In the just-issued nineteenth annual report of the Interstate Commerce Commission on the statistics of Railways in the United States, figures are given covering the results of railway operation during the year ending June 30th, 1906, and a comparison of them with the corresponding figures for 1900 may serve as a text with which to introduce what I have to say. The ton mileage of the railroads operating in 1900 was 141,596 millions; in 1906, 215,877 millions—an increase of 52½ per cent, of which 40 per cent occurred during the latter year. Though the mileage increased by no less than 31,017 miles during the six years, freight business was received and taken care of so well that the density of freight traffic, measured in tons

carried 1 mile per mile of line, increased from 735,352 to 982,401 or about 35 per cent. The mere fact that the railroads were able to take care of this remarkable increase is an indication of the entire inappropriateness and injustice of those general charges of inefficiency which superficial observers, including some writers for the press, have felt themselves free to make. So great an achievement has been possible of accomplishment only by reason of the fact that past freedom of development (subjected though it has been to certain restrictions) has stimulated the growth of the most enterprising railroad policy in the world, admirably suited, in many ways, to its economic environment; it is not denied that this freedom has permitted some evils to thrive, though less during the last few years than previously.

The freight car equipment during the period was enlarged from 1,365,531 cars to 1,837,914 or 34½ per cent increase. At first glance, this compares unfavorably with the 52½ per cent increase of business. That this is not really so is obvious when the capacity of the car is taken into account. So far as I can judge from the equipment statistics, the increase of average capacity from 1900 to 1906 must have been close upon 20 per cent. Assuming that this increase of capacity were made full use of, the increase of car accommodation would be 61½ per cent. The enlargement of the freight car was not accompanied, however, by a raising of minimum weights, so that, in some cases, shippers made no practical use of the extra space facility. Hence, we cannot regard the whole of the 61½ per cent as an actual increase of facility to the shipping public: it requires modification in proportion as the average car loads shipped by the various industrial and commercial concerns were not easily susceptible of increase. It must be borne in mind that, primarily, the transition to higher capacity cars is in the interests of the railway operator. Subject to a certain amount of qualification, it may be said that, under normal conditions, the shipper prefers smaller cars and more of them to larger cars and fewer of them. But, in either case, the practical meaning of the car to him is measured by the position of carload minimum, marking as it does a very considerable difference in transportation charges. Of course, in the long run, under a competitive régime, the shipper is deeply interested in the high capacity car proposition because its utilization, in preference to smaller cars, means greater economy of operation, part of the benefit of which is likely to go, sooner or later, to the shipper.

The idea suggests itself here that, while working towards the higher capacity car, the railroads would be unwise to attempt to impose it upon the shipping public unless the conditions of freight movement were favorable, otherwise considerable inconvenience might result to those whose business organization and relations could not readily be adapted to larger units of distribution. Thus, if increase of car capacity were the sole consideration, an increase of car

equipment (but not of car numbers) corresponding with the growth of tonnage to be transported, though theoretically a desirable achievement, might be no small impediment to the manufacturer and dealer in their efforts to attain maximum business expansion. It is to the credit of the far-sightedness of the leaders of railway policy that, while fostering, for several years, the growth of the larger and more economically operated car, they refrained from even the appearance of coercion in connection with their economical utilization. Thus from the beginning of the present century, the increase of car size steadily proceeded, generally speaking without any notable sacrifice of number, but the carload minimum remained stationary.

The last general movement in the direction of increase of minimum carload weights was, I believe, in 1899, when under the Official classification, general weights were raised in all the classes from 20,000 to 30,000 pounds, after having stood at 20,000 pounds for third class and higher, and 30,000 pounds for fourth class and lower, during a number of years. At the same time, the Western classification minimum for lower than third class was raised from 24,000 to 30,000 pounds, four years previously the minimum for lower than third class had been increased from 20,000. The Southern classification minimum of 24,000 pounds for all classes has remained undisturbed, for all practical purposes, during the last twenty years. Recently, however, a movement has set in towards an advance of existing minimum weights, to accord with the very pronounced advance of the last few years in average car capacity, and this has already found partial, though not very startling, realization in the Official classification.

The policy of the railroads, it is plain, has been marked, in this regard, by great conservatism, and they have amply showed their desire to allow reasonable time for the assimilation of shipping methods to the improved car facilities. They are hardly open to charges of arbitrariness or inconsiderateness in now attempting to take an active step towards the realization of aims long announced, looking to the more effective use of the car accommodation they have provided. If there be any room for criticism at all, it should be directed towards the actual increase of minimum weights in individual cases with regard to the effect of the same upon existing methods of distribution in the industries concerned. But no general opposition to the increase of minimum weights simply because it is an increase is logically well grounded, under the conditions.

The possible effect of the actual organization of the distribution of products in hindering full use being made of increased car capacity, secured through the substitution of a smaller increment of higher capacity cars for a larger increment of smaller capacity cars, has now been considered. It may be further observed that changes in the general character of production, while not preventing full use of car space provided, may similarly hinder an increase in car ca-

pacity, equalling in percentage the increase of business to be handled in ton miles, from establishing an equality of adjustment of freight equipment to traffic. The character of the tonnage may have altered so that equality of car adjustment can be secured only by a relative increase of car capacity. For instance, to take a hypothetical case of as simple a character as possible, if the tonnage at the beginning of the period of comparison were three-fourths coal and pig iron and one-fourth merchandise and hay, whereas, at the end of the period, the proportions were half and half, each cubical foot of car space would be less efficient on account of the greater space demand of each average ton of freight carried. To some extent, a movement of this kind has been in operation, but, by reason of the continued marked preponderance of heavy freight in railway tonnage, probably not sufficiently to reduce very materially the effectiveness of increase of car accommodation calculated on nominal capacity, yet it is worth bearing in mind that the real working capacity of a car is not its stenciled maximum, or, rather, that plus the additional ten per cent allowed, but the average tonnage it can accommodate of the class or classes of freight it is commonly required to convey.

So far as the practical results of American freight operation of recent years are concerned, it is not at all difficult to demonstrate that, coinciding with the movement towards a high tonnage car, there has been a material increase in average load, indicating that, to a certain extent at least, such a car has proved adaptable to modern methods of industrial distribution. To quote a few roads indiscriminately, the average carload per loaded car during the period 1900 to 1907, increased with the New York, New Haven and Hartford from 10.2 to 13.4 tons, with the Norfolk & Western from 19.9 to 25.5, with the Wabash from 14.9 to 18.1, with the Louisville & Nashville from 15.3 to 18.7, with the Illinois Central from 13.7 to 17.8, with the Southern from 12.7 to 14.8, with the Chicago & North Western from 13.8 to 15.3, with the St. Louis & San Francisco from 13.6 to 15.9, with the A. T. & S. F. from 12.7 to 15.5, with the Northern Pacific from 13.4 to 17.8, and with the Great Northern from 16 to 20.4 tons. According to the 1906 statistical report of the Interstate Commerce Commission, the loaded freight car miles for that year amounted to 11,410,599,327, and, as before stated, the ton-mileage to 215,877,551,241. From these figures, it appears that the average load per loaded car of all systems was 18.9 tons. It is impossible to say exactly what the average load was for 1900, on account of the failure of the Commission to collect and publish loaded car mileage before 1901, and, by the way, their Public Service tables still neglect the average load per loaded car. However, the average load for 1901 was 16.5 tons, and, after an examination of the reports of a considerable number of railroads, I am inclined to think that for 1900, the corresponding figure must have been, approximately, 16 1-5 tons. Thus the increase of average load per loaded car was about 17 per

cent. The proportion of this increase due to higher capacity equipment and to improved loading methods respectively are not capable of being determined. After having observed loading methods fairly closely during the period, it does not strike the writer that there has occurred any particularly marked advance in this direction. The exceptions to this general statement are but sufficient to "prove the rule." Accordingly, I prefer to credit the higher capacity equipment with the greater part of the improvement. From 1900 to 1906, then, a twenty per cent increase in average capacity has been met by a seventeen per cent increase, or thereabouts, in average load, indicating, as already remarked, the suitability of the high capacity car, within certain limits, to present industrial conditions. From this it follows that the deduction to be made from the 61½ per cent increase of total car capacity during the period of our comparison, on account of shippers being unable to use to advantage the extra space of each car, is but small, and, assuredly, not sufficient to reduce the per cent increase of effective accommodation below the 52½ per cent increase of business.

In the matter of adequacy of car accommodation, therefore, I fail to see how there can be any reasonable dissent from the conclusion that, under the unprecedented boom of business, the railroads, as a whole, have done astonishingly well in keeping their equipment level, and probably more than level, with the rapid increase of agricultural, mining and manufacturing output.

I say this of the railroads as a whole; thus qualifying my statement because there are individual roads of which it could not be made, just as there are other roads of which more than this could be said. Quite a few railroads have not only managed to keep level with present needs, but have even anticipated future requirements, evidently determined, whatever the cost may be, to provide an adequate amount of car accommodation for their patrons. On the other hand, there would appear to be roads who are not indisposed to piece out their own inadequate car resources with forced loans from their more plentifully supplied neighbors, a larceny which the current of traffic hinders these good neighbors from effectively stopping. The saying attributed to a certain wit: "God help you if you get into the hands of your friends" is entirely apropos of the freight car situation in some respects. Curiously enough, some of the roads who, according to the bulletins of the committee of car efficiency, have been maintaining on their lines a marked excess of cars (amounting, in one case, to fifty per cent, and, at times, to a hundred per cent over the number owned),[1] have really not done badly in the increase of their cars during recent years as compared with the increase of their business. For instance, in the case to which I have made

[1]The statement refers, of course, to the period prior to the present abnormal depression.

reference, the company increased its freight cars, during the seven years ending in 1907, fifty-one per cent, as against an increase of ton mileage of forty-four per cent, the difference being still greater in favor of the equipment when capacity is taken into account. Its record of ton miles per freight car in 1907 does not appear excessive on the face of it, when compared with that of numerous other companies. Of course, the explanation of its persistent retention of foreign cars lies in the nature of its tonnage which is comparatively light and bulky, thus necessitating a larger proportional number of cars than is necessary for roads with heavier freight; its own equipment was evidently inadequate in space accommodation in 1900 (possibly lethargic car movement played some part) and the improvement accomplished subsequent to that date was obviously insufficient to reduce to really moderate proportions its demands upon foreign equipment. The light and bulky nature of the freight carried, occupying much car space per ton, explains also the moderate car ton-mileage record.[2] The unfortunate feature of a policy of foreign car detention is that it necessarily deprives other roads of equipment, usually at the time when it is particularly needed, so that the whole car situation of the country is disturbed. The railroads of the Middle West with their extensive forwarding business are conspicuous sufferers, and the roads in New England, on the Pacific Slope and in the Southwest conspicuous gainers by the inter-line shuffling of cars. In the old days, when freight was transferred at every junction point, it was necessary for each participating carrier to own sufficient cars to haul the freight over its own lines. It would seem proper that the introduction of inter-line organization should not change this requirement. Of course, the proportion of home and of foreign cars on the lines of a railroad will be determined, to a great extent, by the direction of the stream of traffic. Lack of promptness in handling foreign cars will soon swell up the number of such upon a road with the stream of traffic traveling towards it. Given a fairly dense and growing local traffic, substantial moral fibre is required to resist the obvious temptation—sometimes the moral element fails to make good. On the other hand, roads doing a large outward business but comparatively small inward must make allowance for this extra drain in the extent of their equipment. They must expect to be regularly deprived of the use of a certain proportion of equipment, and it is up to them to do the best that they can to keep track of its movements

[2]Heavy freight would have revealed a striking ton-mileage per car. The car ton-mileage, at any one time, is the quotient of the *total* ton-mileage divided by the number of revenue cars *owned*. In general, this represents sufficiently accurately the performance of the average car on the normal railroad, but not in the case of roads with large standing excesses of cars (or the reverse); the real work secured by such railroads out of the cars operated by them can only be obtained by substituting, as the divisor, average number of cars *on line* for average number of cars *owned*. Allowance needs to be made, of course, for private cars.

and to secure the enforcement of mutually agreed upon regulations directed towards securing prompt return.

One of the difficulties connected with *per diem* as a means of stimulating the prompt handling of foreign equipment is that at the times when cars are in most demand it is least effective. Whether the cost of car hire be 20, 25 or 50 cents a day, or even a dollar, it is obviously to the interest of a road short of cars to retain foreign equipment if, during the rush of business, the cars are capable of earning more than sufficient to cover operating and per diem expenses.[3] Conversely, when business is dull and cars less urgently needed by the home roads, low car earnings stimulate the effectiveness of *per diem* to the cost of, it may be, unnecessary empty mileage. There seems much to be urged in favor of a variable *per diem* charge, especially if handled, along with the whole matter of car interchange arrangements, by some permanently organized central bureau of the railroads. This is a tempting subject to dilate upon, but one impossible to discuss adequately in this paper.

Reference to the problem of car interchange brings our discussion very close to the matter of car shortages, the recent acute attack of which was so dramatically terminated at the close of last November by the financial crisis, whose industrial effects are still lingering with us. The more one studies the car situation in general, the more

[3]Suppose that, during the very active season of the business year, a car is capable of earning $2.50 a day after the costs of hauling the car and handling the freight (but not the maintenance charges against the car) are deducted. The railroad has more business than it can handle promptly with its own equipment, and, therefore, must either build extra cars just for the traffic of this road or it must borrow. If the period extends over, say, three months, then, if it builds, it ought to debit all expenses of the cars to that short period. These expenses, in the case of a modern car, a forty ton steel underframe box car, for instance, probably average somewhere about 40 cents a day, the expenses of maintenance and renewals being distributed over the year, the car being assumed to be in more or less constant use. The estimate is based on $1,025 as the cost of such a car, with 20-25 years as average life, 5 per cent interest on cost of car, $85 or thereabouts as cost of repairs and renewals, allowance also being made for maintenance of repair tracks and sheds and rip tracks, tools and the like, including interest on the capital invested in them. But in the case before us, these expenses have to be distributed over but three months, allowance being made for lighter repairs, longer life of car, etc., on account of its more limited use. It is not possible to do more than estimate very roughly the appropriate charge against each day of the earning period but it probably would not be less than $1.25 a day. Thus to earn the assumed $2.50 a day, the railroad must spend (and could well afford to spend) $1.25 a day during the period of the employment of the car if it should provide its own car. But if it borrows other companies' equipment for the period, it will incur hardly any maintenance charges, probably not amounting to as much as 25 cents a day, at the most. So that, under the assumed conditions, there is no inducement for the road to provide its own extra equipment, even if a dollar per diem were levied upon it, and, with a 50 cent or 75 cent per diem, it is considerably in pocket by borrowing equipment which it can send home as soon as it has no further use for it.

one realizes that the intensity of such car famines, as they recur from time to time, could be materially relieved if more skillful attention were applied to the supervision and improvement of the distribution and of the mileage performance of cars both in local and in interline business, the crowning difficulties of railroad operation. In speaking thus, it is not intended to have inferred that, under any reasonably economical system of car equipment, the railways could obviate such shortages. As a matter of fact, the charges of gross inadequacy of equipment, so freely made by choleric shippers during periods of car shortages, are based entirely upon the reasoning that there is a shortage, that the railroads have no business to allow a shortage to take place, and that its existence is sufficient evidence of willful neglect on the part of the railroads to provide a proper amount of equipment. No consideration is given to the relation of that equipment to business requirements during the periods when surpluses take the place of shortages nor to the possible loss which may result to a railroad maintaining an extra supply of cars whose service is necessary, perhaps, only three months out of the twelve. Unless the daily earnings of such cars during the limited period of their necessary service are sufficient to cover not only the costs of handling the freight, of moving the cars, of use of roadbed, terminals, motive power and so forth, but also interest on capital invested in the cars, maintenance charges, depreciation and insurance, and storage accruing during the whole year, it is patent that the provision of such cars would be a pure act of charity on the part of the railroads, and in no sense a commercial transaction. I am not going to assume gratuitously that it would be necessarily unprofitable for any specified railroad to provide this extra equipment, but note the possibility as something that needs to be investigated before charges of incompetent management are rested simply on shortages in car supply during busy seasons. And in connection with estimation of car shortage, it should be noticed that the extent of the same is not accurately measured by shippers' demands, since they frequently order more cars than they really need in the hope of securing a larger number than they would otherwise be likely to do. The actual shortage at any date is, undoubtedly, less by a considerable percentage than the total of the shippers' nominal requirements.

Moreover, while this shortage is a very real difficulty at the times of its recurrence, it is, in large measure, the result of a tendency on the part of shippers to keep their stocks down to the working minimum, frequently involving procrastination in the ordering of their supplies. An annual example of this is to be found in the coal trade in which the dealers regularly fail to make long enough preparation ahead for the fall trade, so that, with the advent of the cold season, orders for cars are rushed in with instructions that they are to be treated as urgent. They (and many others) are anxious to combine all the advantages of keeping as little capital as possible tied up in

their stocks with an absence of all the disadvantages that naturally attach to the undue crowding of business. A little earlier preparation, even if at the expense of tying up more capital in the shape of stocks and storage facilities, would, in many cases, be entirely reasonable, and a legitimate expense of the business. At any rate, if this natural organization of their business arrangements is not attended to, such traders hardly ought to feel aggrieved if their aggregated demands make it impossible for the carriers to reply as promptly as they desire.

From what has been said, it must not be supposed that the railroads, on their side, are keeping down equipment to the level of the traffic of the least active seasons. As a matter of fact, they are providing cars in marked excess of this, and an appreciable portion of their equipment is lying idle or running light during the "off" season. The actual extent of their equipment is a compromise between the requirements of the periods of maximum and minimum trade. The railroads, of course, will continue to increase equipment so long as there is a reasonable profit arising from the receipts of the car during its active period after deducting the charges against it during both active and inactive periods. It is not easy to see how more than this can be expected from the railroads,[4] though it may happen, in consequence, that cars demanded during only three or four months of the year are not supplied. Shippers do not always realize that the surplusage of cars is quite as important a matter to the railroads as shortage is to them. The railroads are most keenly interested, naturally, in balancing supply with average demand, though even then they are liable to be hit pretty hard by business depressions, as witness the 300,000 car surplus during the past two months, the expense of whose enforced idleness (if cost of repairs, renewals, insurance, interest and storage be considered as distributed equally throughout the year) can hardly have been less than four and a half million dollars.

There are then, difficulties on both sides. But I have already indicated that shortage evils are accentuated among the roads themselves by the action of certain companies in persistently retaining and improperly using the equipment of other lines, thus reducing the pressure upon themselves, but, at the same time, causing it to be more widespread. *Per diem* arrangements so far tried, though an improvement upon the old mileage system, have failed to bring about an equitable distribution. A resort to car pooling methods really appears to be the only alternative, if economy of equipment is to be a consideration at all. Granted that capable administrators can be found to take charge of such pools—and no one familiar with the official personnel of the railroads would deny this—their

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[4]In the matter of car equipment, that is, as apart from the question of car movement.

influence upon the car situation in general would be very real. Possibly, there could be established district pools with jurisdictions covering, say, Official classification territory, Southern classification territory, the Southwest, the St. Paul, Chicago, St. Louis, Kansas City and Denver territory, and the territory between the latter and the Pacific Coast, each of these district pools focussing in a central distributing office, which would receive full reports from the district pools and would arrange for transfer of equipment from district to district when necessary. In each district, the pooling principle could be made to apply separately to each of the major varieties of cars, and, possibly, though the practicability of this is not quite clear, with a rough reference to their capacities. I have sufficient faith in the genius of the American railwayman to believe that the details of some such plan could be worked out satisfactorily. It is not unnatural that reluctance to enter into a car pool arrangement should arise from the dislike of some roads to hand over the management of part of their equipment to an external authority, and from a fear that they will thereby get the worst of the transaction. Indeed, it is very likely that, during the formative period and early operation of such a scheme, equitable distribution would fail, at times, to be attained, but, in the long run, it would surely work out to the general advantage of all the roads concerned, except in the case of those who now habitually rely upon other people's supply to make good their own deficiences, and these we are not called upon to take into consideration.

Before concluding this paper, I should like to supplement the figures, with which the discussion of adequacy of car equipment was introduced, with one or two more relating to the cognate and equally important question as to how far such equipment is used efficiently. We have seen that the typical car of 1906-7 is considerably larger in capacity than the typical car of 1900; it is also performing a somewhat greater actual service. The real efficiency of a freight car is the resultant of two forces, if I may borrow the language of Mechanics, one the average load, the other the mileage it covers, that is, its average rate of movement. Put into figures, the measure of this product in 1906 was 117,450 ton miles as against 103,700 ton miles. in 1900, an increase of 13,750 ton miles per car, equivalent to 13¼ per cent.[5] The average load for 1900 has been estimated at 16 1-5 tons, and from this it follows that the loaded miles per car averaged 6,285: in 1906, the corresponding figure was 6,208. This indicates a backward movement so far as the matter of car movement is concerned. But there are reasons why this result should not be accepted at its face value. By reason of the absence of proper statistical data covering the whole of the railway systems of the country during the years of comparison, I have been obliged to base the loaded mileage performance of each car upon the number of revenue cars owned at the end of the fiscal years. Obviously, the car mile-

age is made by the average number of cars owned throughout the year. If it were to be assumed that the net increase of cars, during 1900 and 1906 respectively, took place uniformly during these years, then the figures given above would be changed to 6,450 and 6,396, the decrease of miles per car being thereby reduced from 77 to 54. In dealing with the comparison of individual railroads, it would be necessary to take into account the fact that, at different periods and with different roads, the proportion of cars used in making the mileage to cars owned may vary, but, in dealing with all systems collectively, this is obviously unnecessary.

A further reason for neglecting the apparent decrease in car mileage lies in the omission of privately owned cars from the calculation, though the results of their movement are included in the record of total loaded car miles. If the proportion of private cars were the same in 1906 as in 1900, the net decrease as shown above would be slightly reduced, though the percentage of decrease would not be altered, of course. Private car statistics are not available but I should take it as unlikely that such cars attained quite as large an increase (relative) as railway owned cars, and, if this be true, a more appreciable reduction in both the absolute and the percentage decrease took place. For instance, private cars in 1900-1 were estimated to equal from seven to eight per cent of railway freight car equipment. If, during the following six years, they increased but twenty per cent in number as against the thirty-five per cent of railway owned cars, the net decrease of loaded car miles per car would be reduced from 54 to 19.

A still additional reason for modifying the result first arrived at is to be found in the varying nature of railway tonnage over the period. Coal and other mine traffic tends to limit the mileage performance of the cars engaged in it and, when such traffic increases more rapidly in volume than the rest, the effect upon general car mileage average is depressive. Undoubtedly, this has taken place, to a certain extent. The products of mines in 1906 accounted for more than 53 per cent of total originating tonnage, whereas, in 1900, the proportion was slightly over 52½ per cent. Mineral ton mileage and car mileage figures are not accessible but, no doubt, this movement is reflected in them, and though the difference in percentage is hardly large enough to exert much influence upon the average per car, it would probably be sufficient to wipe out the decrease with which the present analysis of car mileage averages started.

It is satisfactory to find that, the railway freight service being taken as a whole, there has been no absolute retrogression in the movement efficiency of the freight car, and yet unsatisfactory not to be able to say more than this. The efficiency of the freight car of 1906 over the car of 1900 is due entirely to improved load: there has apparently been no appreciable improvement in the average number of miles travelled per annum. Except in so far as the trader

was able to secure lower rates, a supposition hardly justified by the facts, the benefits of the increased efficiency of the freight car during the period 1900-06 must be regarded as having been in favor of the railroad rather than the trader.

It is a somewhat remarkable fact that the power and ability displayed by railroad managers in so many directions has been unable to secure tangible improvement in a matter which is more vital than most things to the really economical and successful handling of a railroad. In scanning the results of freight operations during the half dozen years covered by the main figures of this paper, one may observe with pride the handling of an increase of business of 52½ per cent, with a train mileage increase of but 14 per cent (492½ millions to 559½ million miles), and a consequent increase in train load of 42 per cent (271 to c. 385 tons), accompanied by an increase of 17 per cent or more (c. 16.2 to c. 18.9 tons) in car loading, but car mileage—the less said about it the better! Perhaps, it is incapable of improvement! But the query is inevitably provoked as to whether some of the improvements named have been purchased at too high a cost. The bulletins of the committee on car efficiency reveal great differences between the various roads in the mileage results obtained from their cars. Unquestionably, varying physical and economic conditions play an important part in these differences, yet one cannot help but believe that the personal equation, the organization of the railroad, is no trivial factor. To take but one illustration, the reports published impress one with the idea that a great deal of misapplied economy is frequently exercised with regard to shop repairs. No doubt, a road hauling heavy tonnage over adverse grades and around sharp curves must expect to be troubled more with the question of car repairs than a road working under the reverse conditions. Yet even in this case, the loss of car time may be seriously increased by lack of proper provision of shop facilities, usually a poor kind of economy, and, to the extent to which shop repairs accumulate, a lessening of the effective equipment of the road. In studying the returns covering July 1906, to August, 1907, one is surprised, again and again, by the high percentages of cars in shops, and high not merely during the period of slack business. Some roads apparently maintain, during the major part of the year, eight, nine, ten per cent of their freight equipment, or even more, as shop ornaments. More attention needs to be given to shop policy, and, one might add, to the treatment cars receive in the yards; with the needed improvement, one hindrance to better freight car performance will be removed.

Yard working affords even more fruitful opportunities of improvement. Terminal yard delays is a vexed problem that is apparently eternal in nature. Poor yard design, or, to be more correct in many cases, lack of design, has been condemned again and again as too common a feature, but it is by no means an unknown thing

to find the evils of bad design supplemented by those of poor organization and still poorer management. I think a mistake has been made frequently in locating terminal yards too near the centers of the cities, though sometimes the growth of a city has been so rapid as to reach out to fairly distant sites, crippling the possibilities of their expansion by the immense resulting increase in land values. Again the storage privileges of terminal yards have been notably abused: to judge by the space which railroad managements are often prepared to assign to storage tracks in response to the "needs" of the shippers, they do not always realize that, in the physiology of the yard system, the function of the storage yard is about that of the vermiform appendix. It is satisfactory to note, however, that demurrage regulations are being rounded into more uniform shape over the country at large and, with their steady enforcement, less trouble from shippers' delays can be expected.

Much more could be profitably said about the influence upon loaded car mileage of such trans-shipping arrangements as the Pennsylvania provide at Fort Wayne for the making up of "through" loaded cars at that point, thus reducing the pressure upon the Chicago yards, and much more upon the general extension of "consolidation" arrangements in relation to both increased average loading and mileage. A further interesting question is that of adequacy of motive power and the desirable ratio of such power to freight business and equipment: in this matter, as in so many others, there are marked differences in the practices of the various roads, the justification of which it would be desirable to have explained. These and many other sides of the question of freight equipment efficiency must regretfully be excluded from a paper already over-long, but I hope that some of the speakers will favor us with their opinions upon these subjects.

The lack of progress along the lines of car mileage is in such astonishing contrast with improvement in other branches of railroad operation, that everyone feels that something should be done to remedy the situation. There are many factors contributing towards a low daily car-mileage which are unavoidable, but advance along the lines suggested, and, perhaps, more radical measures, will certainly do something towards raising the present standard.

ADDENDUM.

The previous statistical analysis rests upon figures covering the operations of all systems, both large and small, during the years 1900 to 1906. It will be interesting to see how the general results are borne out and, indeed, emphasized, over a larger period, by the statistics of a group from which very small roads are excluded.

These are compared below, in the case of thirty-one railroad systems, some of the operating results of 1907 with the corresponding

ones of 1897, a ten year period. The roads whose statistics were available are the following (arranged in alphabetical order):

A. G. S.	C. C. C. & St. L. and P. & E.	K. C. S.	N. P.
A. T. & S. F.	C., M. & St. P.	L. & N.	Penna. R. R.
B. & O.	C. N. O. & T. P.	M. C.	Rock Is.
B. & M.	Erie.	M. & O.	St. L. & S. F.
C. of G.	G. N.	Mo. Pacif. and St. L. I. M. & S.	St. L. S. W.
C. & O.	G. T.	N. Y. C. & St. L.	Southern.
C. & E. I.	I. C.	N. & W.	T. & P.
C. & N. W.			U. P.
			Wabash.

In 1907, these railroads were handling considerably more than half the railroad traffic of the country, and hence, in spite of some prominent omissions, are well representative of the more important systems. They owned 538,830 revenue freight cars in 1897 and 1,065,548 in 1907, an increase of 97.8 per cent. In calculating the average capacity of these cars, I have been compelled to omit, in 1897, the L. & N., N. P., Rock Is., Mo. Pacific, B. & O., St. L. & S. F., Southern, C. of G., and K. C. S., representing a total of 140,074 cars, on account of average capacity for that year not being ascertainable, but I have added to the list previously given the C. B. & Q. with 36,469 cars. For 1897, accordingly, the average capacity has been based upon 23 roads with 435,225 revenue freight cars, having a total capacity of 9,780,211 tons, thus giving an average capacity of 22½ tons. For 1907, I have had to exclude four roads, the L. & N., C. of G., K. C. S. and Mo. Pacific, with 94,348 cars, but have again added the C. B. & Q. with 47,164 cars, making a net total of 1,018,364 cars, having a total capacity of 34,481,517 tons, or an average capacity of 33.9 tons. On account of the large number of cars included in the calculations, the omission of the roads named cannot materially affect these averages. An increase from 22.5 to 33.9 tons represents a percentage increase of 50.7, from which we can see, much more clearly than in the case of the general statistics covering the shorter period, the really great advance made by the larger and more progressive roads in the direction of the increase of car capacity. When this 50.7 per cent increase of car capacity is combined with the 97.8 per cent increase of car numbers, an increase of 198 per cent of car accommodation is shown. How does this compare with the growth of business handled by these roads? The thirty-one systems handled, in 1897, 53,046,151,280 ton miles; in 1907, 136,037,276,970 ton miles, so that against the 198 per cent of car accommodation there has to be set only 156½ per cent increase of ton mileage. The average load per loaded car mile was 13.4 tons in 1897, and 19 tons in 1907, an increase of 41.8 per cent.[5] This substantiates the statement made in the body of the paper that there has been evidently a fairly economical utilization of the extra capacity of the enlarged car.

With respect to car movement figures, the 3,901,494,854 loaded car miles of 1897 represented 7,407 loaded car miles *per revenue car owned*. In 1907, the 7,143,781,875 loaded car miles average out to but 6,704 loaded miles per car owned, an apparent decrease of 9½ per cent. With some of the most important roads included in the averages, the decrease reaches as high as 15½ to 19 per cent. As noted already, these percentages would undoubtedly undergo reduction if adjustment were made for (1) average number of cars owned throughout each year, (2) railway cars owned but not on lines, or vice-versa, (3) average number of private cars operated throughout each year, and (4) proportion of coal and similar car delaying traffic to total traffic. It will be understood from previous remarks that the percentage results can be affected by adjustments under these four heads only when there is, in any of the cases, a percentage variation in the years compared. Should the proportions remain the same, the percentage of decrease could not be influenced by such adjustments. It is not unlikely that some roads would find it extremely difficult to account statistically for the whole of the decrease.

The President: The Secretary has a communication on the subject.

The Secretary: I might say that I sent out some twenty or thirty copies of this paper to the car service men of the roads entering Chicago, and, as the President says, the meeting in New York of the American Railway Association has taken most of them away. I hope, however, before the paper goes into the proceedings, to have some further written discussions which I will incorporate in the proceedings and give the Professor an opportunity of answering.

I have one communication from Mr. George G. Yeomans, Assistant to the President of the Wabash Railroad, which I will read.

Geo. G. Yeomans (Asst. to President, Wabash R. R.): I just got in off the line and find your favor of the 16th instant inviting me to take part in the discussion of Professor Dewsnup's paper on Freight Car Efficiency at the Tuesday evening meeting. I regret very much that a previous engagement will prevent my being present, particularly so as I am much interested in the subject under discussion, and because the paper to be presented by Professor Dewsnup presents the matter in a most careful and logical way, and in a most conservative and dispassionate manner. His analysis shows a most painstaking study of the statistics necessary to a complete understanding of the situation and yet there are one or two

[5]The average is based on the 31 roads named in the list with the exception that the B. & M. could not be included in the average for 1897 on account of the absence of loaded car-mile figures for that year.

features which he merely mentions in passing, and which I believe have a more important bearing on the subject than he seems to think should be accorded to them.

He touches very lightly on the treatment which freight cars receive in the yards and bears a little more heavily on what he calls shop policy and the lack of shop facilities. I think it is true that taking the railroads of this country as a whole, their shop facilities have not been increased in the same ratio as the increase which has taken place in the number of freight cars in service. It is quite an open question, however, whether the railroads would be justified in so largely increasing the investment in shop buildings and machinery which would only lie idle in times like this, even to the same extent to which they might be justified in increasing their investment in freight cars, so many of which are also unproductive at present. It seems to me that there is less excuse for this additional investment in shop facilities than there is in freight cars themselves, partially for the reason that there has been of recent years, a very considerable number of small independent repair shops established by outside capital which the railroads have availed themselves of to their utmost capacity, and in busy times when all of their equipment is in service and the roads are making more satisfactory earnings, they can better afford to pay a reasonable profit to these independent repair shops than to assume the increased fixed expense which would be the result of any considerable investment in additional shop facilities. I believe this may be regarded as one of the reasons why the shop facilities of the railroads have not kept pace with their equipment. I have not studied the statistics of this subject as thoroughly as Professor Dewsnup and consequently am not prepared to controvert the general statement whch he makes as to the percentage of equipment in the shops during the period he mentions, but I do know that so far as the lines with which I am connected are concerned, our percentage of bad order equipment seldom, if ever, exceeded 5 per cent during that time, and was sometimes as low as 2½ or 3 per cent.

Another point which has an important bearing on this part of the subject is the increasing carelessness of employes engaged in the handling of trains, which has been a noticeable feature of railroad operations in the past few years. I think that practically all railroad officials will agree that this has been a real factor and not an imaginary one.

It is due to several causes: the universal adoption of automatic couplers and other safety devices rendering it unnecessary for the men to expose themselves to any danger in operations which were previously performed by hand has led to less care being used; the scarcity of labor due to the unprecedented amount of business being done rendered them practically immune from danger of discharge from service where damage was caused as a result of carelessness

on their part in the performance of their duties, and in case they were discharged, other positions were waiting for them.

The increased amount of work which was required, in itself necessitated greater speed and less care in its performance, and the increased weight and power of both the rolling stock and the loads carried, all tend to bring about more disastrous results as a consequence of any carelessness. All of these causes tend to increase the number of cars requiring repairs.

Another element which has a very important bearing on the question of freight car efficiency is the free time allowed for loading and unloading of cars. In many cases this is the result of State laws which have been passed by the legislatures at the demand of the shippers. It has been the general practice to consider 48 hours as the standard free time allowance for loading and unloading of a freight car. It would seem as if this should be amply sufficient if not more than really necessary, and yet no less than 16 States have passed laws compelling the railroads to grant more time, the allowance running from 60 hours in Georgia to as high as 144 hours under certain conditions in Alabama. If we take the recognized standard of 48 hours and admit that it applies to each end of a given trip, and compare it with the time consumed in the transportation while the car is actually in motion, the results are somewhat startling. For example: On a very busy piece of single track line 500 miles long, during one of the periods of greatest congestion last year, it was found by actual calculation that the freight trains while in motion were proceeding at the rate of about 16 miles per hour, or 160 miles per ten hour day. Assuming for the sake of the argument that the average movement did not exceed ten miles per hour or 100 miles per day of ten hours, and that we are considering an average trip of 250 miles, we have the car employed for 121 hours of which only 25 hours is taken by the railroad in transporting it for the distance named. If the free time allowance for loading and unloading the car could be reduced 25 per cent or from 48 hours for each operation, to 36 hours for each operation, it would mean a saving of 24 hours in the round trip or practically 20 per cent. In other words, four cars under such conditions would perform the service for which five cars are now required, and taking the car equipment of the country as roughly 2,000,000 cars, the increased efficiency thus obtained would have the same effect as an addition of 400,000 cars to the freight car equipment of the United States.

There are, of course, a number of other features along this general line which go to detract from the efficiency of the modern freight car, such for example as the increased size of water carriers, requiring the accumulation of much larger numbers of cars at the point of trans-shipment in order to provide the necessary cargoes, etc., but I have not time to touch upon them here.

The Secretary: That is the only communication I have, Mr. President.

The President: The matter is open to discussion, gentlemen, we will be glad to have any one take part.

Mr. E. E. Betts (C. & N. W. Ry.): I notice this paper which reached me this morning is accompanied with the request that we prepare a discussion on it. I did not have time to prepare a discussion. but if I did I presume it would be a great deal like the young minister who invited his uncle to come to hear him preach, and after he got through he was very anxious to know what his uncle thought of his preaching, and after much persuasion his uncle told him that in the first place he read the sermon; in the second place, he read it very poorly, and in the third place, it was not worth reading. (Laughter.)

I have been very much interested in reading this paper, and am sorry I have not had time to more thoroughly digest it. There are, however, a few things that have come to my mind which I will endeavor to discuss.

In the first place, I have marked on page 7 a portion of this paper which I will take the liberty of reading:

"The unfortunate feature of a policy of foreign car detention is that it necessarily deprives other roads of equipment usually at the time when it is particularly needed, so that the whole car situation of the country is disturbed. The railroads of the Middle West with their extensive forwarding business are conspicuous sufferers, and the roads in New England, on the Pacific Slope and in the Southwest conspicuous gainers by the inter-line shuffling of cars. In the old days, when freight was transferred at every junction point, it was necessary for each participating carrier to own sufficient cars to haul the freight over its own lines. It would seem proper that the introduction of inter-line organization should not change this requirement. Of course, the proportion of home and of foreign cars on the lines of a railroad will be determined, to a great extent, by the direction of the stream of traffic. Lack of promptness in handling foreign cars will soon swell up the number of such upon a road with the stream of traffic traveling towards it. Given a fairly dense and growing local traffic, substantial moral fibre is required to resist the obvious temptation—sometimes the moral element fails to make good. On the other hand, roads doing a large outward business but comparatively small inward must make allowance for this extra drain in the extent of their equipment. They must expect to be regularly deprived of the use of a certain proportion of equipment, and it is up to them to do the best they can to keep track of its movements and to secure the enforcement of mutually agreed upon regulations directed towards securing prompt returns."

During the past five years, this moral element that is spoken of here has grown beautifully less. I think that the per diem settle-

ment of cars is the only proper and logical method, and there appears to me to be no reason on earth, nor beyond, why the property of railroads should not be treated by those who receive it the same as any other private property.

Later on in this paper is a reference to pooling, and that is made necessary, according to our friend, by reason of the fact that the fellow who gets your property will not send it back. It seems to me that the solution of the car problem in this country is common honesty and I believe that there is just one way to secure that and that is by—I won't say an agreement of railroads, because I have never seen any three or four railroads agree among themselves on the car question and stay by it when there was any business in sight—but I believe that there ought to be a regulation that would cause a fine of, say about $100, to be inflicted for each violation thereof for stealing a foreign car. In the first place, I believe that there should be broad and sufficient rules promulgated that would enable a railroad company to economically handle a car, that is, to load it in both directions.

A large railroad company, if it knew that its equipment would be returned within any reasonable time, would be able to provide itself with sufficient equipment to meet its needs. Equipment must of necessity be interchanged; that is the law of the land, and it is common sense, and the business men and the business interests of this country demand that the equipment be interchanged. But if a large railroad originating a large traffic is obliged to buy 10,000 cars and during the heavy movement of traffic gets one load a year, (and it is in luck if it gets that), then it would certainly take an enormous capitalization to provide itself with sufficient equipment to handle its own business and that of the other fellow at the same time.

So it seems to me that the problem is one that could be easily solved and that by simply being honest, and I do not believe that it ever will be solved until there is sufficient penalty attached to the improper confiscation of any railroad property just the same as in private business.

Sometime since, I do not know just how long ago, but a year or so ago, there were laws passed by the Federal Government whereby it was unlawful to keep stock in cars longer than a certain period. Prior to that time, they were kept in longer, if necessary, or desirable, but the Government got hold of that proposition and issued a law to the effect that stock must be only confined a certain number of hours. Uncle Sam ordinarily has a means of getting people out to see that these things are done, and if you do not do them, it will cost you $100 per. Now there are not very many violations of that law, and ordinarily a division superintendent or anybody else that has anything to do with that is pretty busy to see that that law is complied with. If there were no penalty inflicted whatever and nobody was out seeing that the other fellow is not

doing what he is supposed not to do, I suppose it would be just the same as the car proposition,—they would keep on violating it.

The car problem is just the same as any other problem of that character; where there is no penalty inflicted, there is no observance of the law. We have laws in this country that say "Thou shalt not steal," but if a man was not put in jail, you would require a lock on your pocket all the time; you would be lucky if you didn't find your wife stolen before you got home. And so it is with the car question.

Professor Dewsnup says: "The more one studies the car situation in general, the more one realizes that the intensity of such car famines, as they occur from time to time, could be materially relieved if more skillful attention were applied to the supervision and improvement of the distribution and of the mileage performance of cars both in local and in inter-line business."

Of course, that may be so in some respects, but at the same time I want to go on record as saying that I believe there is more brains in this country in handling the car business than there was ten years ago, and I believe there will be more ten years hence. We have got to increase in our ability; if we do not, we retrograde. I believe that the science of railroading is more advanced today by considerable; that there is more skill used and that there is more brains engaged in the railroad business than there ever was before.

If I interpret these statistics properly, in a hasty examination, everything seems to be all right with the exception of the car performance. That seems to be a mystery, why we have not increased our car performance. If I were going to own and operate a railroad myself with my own money, and I had a big business, I would not buy so many cars; I would buy more locomotives. The first thing I would have would be something to do the pulling. At least I would have engines to pull the cars I had before I bought any more cars. I would not fill up my side tracks and then buy more equipment, but I would look out for my motive power. There are many and many yards during a heavy movement of business that are full of cars. There are many and many cars that have remained in a good many yards for a good many days without turning a wheel, and the reason they do not turn a wheel is not because of the unskilled work of the supervisors or the distributors, or because they did not get mad and say a good many mean things and jack people up; that is not it, but because there was not anything to pull with.

Now, if Marshall Field handled his own delivery and he had a barn out here and he had about twenty-five more wagons than he had horses to pull, and the wagons were all full of things and the people were waiting for them out in the country and his business depended on delivering those goods on time, he would not buy any more wagons, he would get some more "plugs" as quick as he could to pull those wagons.

If one hundred cars in one yard remain idle twenty-four hours,

it has the same result as taking one car out of service for one hundred days together. If there are three hundred cars in that yard, you practically take one car out of service for an entire year, which you might have the use of if power was available to move those cars when they are ready to move.

Ten years ago we did not have any congestions; we had enough engines to move the traffic that we had and when the cars were ready to go, that train went. Congestions were almost unknown. Of course, there may have been some congestion occasionally due to storms and such delays, but ordinarily we did not have any such congestions as we have met with due to the abnormal increase in traffic during the past two or three years. If State street only had twenty-five vehicles to move, those twenty-five vehicles could move between two given points at a much more rapid pace than 5,000 could, because they have more room to move and they are not stopped at every street corner and three or four times between in order to wait for somebody to get out of the way. So it is in the railroad business,—the more you increase the density of your traffic, naturally the slower your traffic moves.

In the first place, you have congestions in the yards, and, in the second place, where you have a heavy traffic, unless you have adequate side tracks, (and it is not always possible to increase all your facilities within a year or two), naturally your trains move slower, and where you could make 150 miles in ten hours, you frequently, and particularly during the congested period, require fifteen hours to make that same distance.

Therefore, the problem as to why cars have not moved faster, why we have not increased our car performance is no mystery. Of course, railroad managers in providing power to move their traffic always have to look ahead with reference to periods just such as we are encountering now, when there are thousands and thousands of engines and cars on the sidetracks or in the shops waiting for business and on which the capital expenditure has to be made just the same in lean times as in good times. I really believe that in this country we have built too many cars and too few engines.

I had intended to say something on the pooling question, but I believe I have covered about all I want to say.

The President: I am sure we are greatly obliged to Mr. Betts for his discussion, which is very pointed. It occurs to me, in this connection, that the basis of statistics is improperly computed when we consider ton miles only. If we take car performance in connection with ton mileage, we get a basis of comparison of statistics which would be illuminating.

Mr. Betts: There is one other point I want to make and that is, that it is absolutely essential that the railroads do increase the capacity of their cars, as the tendency of legislation is to decrease rates, and we naturally must increase the capacity of our cars, because the greater

the capacity of the cars, the less the dead weight, and unless we advance in that direction, the railroad companies would soon be out of business.

I had occasion to make up a little statement on our road, and the figures showed that for the last fiscal year, while we had an increase of about 45 gross tons per train mile, our net tons increased only about one ton, showing that we hauled 44 tons dead weight additional in our trains, which, of course, is due to the added capacity of the large influx of heavy capacity cars, and the fact that the old cars are getting broken up and out of business, and unless we do increase our net tonnage with those heavy capacity cars in proportion, it makes a more expensive proposition for railroads.

There is just one other fact that I want to touch on, that is, that it is also necessary, and I think that has not gone to the limit, to increase the minimum weight, and as shippers, want cheap transportation and quick transportation, they ought to be willing to take their goods in little larger packages in order to allow the railroad companies to keep pace with the cheapening of transportation.

Mr. B. Julian (G. F. C. D. Union Pacific R. R.): Mr. Chairman and Gentlemen: In reply to Mr. Betts' remarks:

Is it not a fact that the enormous increase of business in the past five years has exceeded all expectations? As a Kansas cyclone —without the least warning—this wave of prosperity came on us, spreading from ocean to ocean, catching us all unprepared.

Can we say that the managements of the various great railroads were at fault in not providing cars and locomotives sufficient to move this immense increase of traffic, unparalleled in the history of the country? Did they not immediately take steps to relieve the situation by ordering thousands of cars and engines adequate to meet the emergency? Did they not order more cars and locomotives than the car and locomotive shops of this country and Canada could manufacture? The car and locomotive shops were in no better way prepared to receive the inrush of orders for new equipment than the railroads had been to receive the increase in traffic.

The demand for material necessary for the construction of cars and locomotives being so great, it necessarily brought on delays in delivery of equipment. As traffic kept improving and more equipment was being ordered, the delays to the delivery became greater, so that now after four months of business depression these car and locomotive shops are delivering equipment which should have been delivered in 1907.

As to railroads using foreign cars under the per diem rule: I wish to say that in October, 1907, we moved from Council Bluffs to the west, 56,000,000 tons of freight and 60,000,000 tons were received at Council Bluffs for the east,—making a total of 116,000,000 tons handled in Council Bluffs yards. Had we attempted to release foreign cars we could not have moved this immense amount of freight.

Eight connecting lines, one of which—the Chicago & North-

western—is a double track road, are all delivering to a single track road. We have been and are now, double tracking the Union Pacific and when completed will be amply capable of handling all the business promptly.

But it is not the fault of the railroad managements if delays were caused. They were not prepared. There was no man living who could have predicted that this country would have had such an increased business in the past five years. Ten years ago it was a pleasure to move traffic on the Union Pacific, so well equipped were we for the amount of hauling there was at that time. In fact we would have been glad to have had a little more. We did not know what real traffic was.

The Oriental business opening up after the "Russo-Jap" war brought on to a great extent—I will say 50 per cent—more business from the East and West, which was not expected five years ago.

Mr. Barnum: Mr. Chairman, the lack of sufficient motive power has troubled some roads in the country, but I have seen cases where there was congestion on certain parts of a railroad, and the more engines you gave those divisions, the worse the congestion became, for the reason that they would get more trains on the road than they could move, and it does not by any means follow that more engines will move more cars on some pieces of railroad, or that shortage is the sole cause of congestion.

Congestions are generally due to a combination of several causes. Most western roads during the past two or three years of heavy business added locomotives to their equipment about as rapidly as they could be furnished by the builders and in fact some of the engines ordered when business was good were not received until after it had fallen off, so that some roads now have engines that have never pulled a ton of freight, because they were not delivered till six or eight months after ordered and in the interval business collapsed.

As to car shops, in the greater part of the United States freight car repairs are made out of doors. While in the extreme northern and southern parts of the country a shop or some kind of shelter is certainly desirable, probably 90 per cent, perhaps even more, of freight cars throughout the United States are repaired on tracks out of doors, so that the matter of additional shop buildings cuts very little figure. This is shown by the fact that many railroads with no additional shops kept the percentage of bad order cars down under three per cent during the time when cars were in demand, and it was more a problem of getting enough men to do the work than it was of additional shops. Some roads had so much trouble in obtaining men to repair cars that the percentage did run up to six and eight per cent, but it was a question of available labor, and not more shops. Many men were sent out to repair points who

never repaired a car but after obtaining from the railroad company a free trip they took other jobs or went on their way rejoicing.

The average miles per day per freight car is an item that varies greatly on different roads, and is subject to many limitations. Some roads during the heavy business of the last two years were averaging only 18 to 20 miles per freight car, while others were making as much as 36 miles per day. I cannot say why that was, but so large a difference would certainly call for some explanation from the roads making the low mileage.

The railroads have been criticised on all sides for not furnishing enough equipment to handle the heavy business, and it is possible that some did not do everything that could be done, but they certainly made strenuous efforts, and if the shippers had made one-half the effort toward quick loading and releasing of cars, the average car movement would have been much greater and there would have been a great deal less complaint about car shortage.

There certainly has been no shortage of laws on the subject for there were over 800 anti-railroad laws introduced in the legislatures of eleven western states last year, and over 100 of them were passed and signed by the governors. Not on of those laws was calculated to increase the efficiency of cars, or increase revenues but most of them were intended to hurt the railroads and have resulted in that way. It seems to me it is up to the shipper to do something to help himself in this matter of car shortage. At the present time there are many thousands of idle cars, but in the event of another era of heavy business, which we hope and believe will come, the shipper can surely do very much more than he has in the past to help himself and at the same time improve the general situation.

Mr. Hennessey: In reply to the first speaker who answered the paper—Mr. Betts—I want rather to correct a statement. If I understood him correctly, he said there was no railroad organization in this country where there was half a dozen roads that would make rules and live up to them if there was business in sight.

I wish to make the statement that there has been a railroad organization in existence for the past forty years, controlling the handling of cars, and making up rules every year to govern such handling of cars. I wish to say, too, that this organization of which I speak lives to these rules honestly, and if a mistake has been made in revising any of the rules, we do not on our way home try to figure how we can evade the burden which the mistake puts upon us, but each man goes back with the full intention of living up to it until the proper time comes for rectifying such mistake. For these reasons they have become a power in the land, and the organization to which I refer is the Master Car Builders' Association. But I must cut off talking from this line of thought as the hour is growing late. I want to refer, however, to another part of the gentleman's statement relative to causes of car shortage. I believe that one of the

greatest cause for car shortage has been due to the fact that people in the extreme west and northwest have made no attempt to assist the railroads by ordering their freight far enough in advance. Train after train has been sent west with only a portion of the cars loaded, and if these western people would observe this and place their orders for supplies so they could be hauled at such opportune times, it would provide a needed remedy all around. The trouble has been that these orders have been placed at the last moment,—just when needed, and then a clamour goes up from every little dealer of coal or lumber or whatever it may be, demanding that his orders be filled at once, but the railroads are never taken into consideration at all.

THE PRESIDENT: Any further discussion? It is pleasant to hear the Master Car Builders' Association standard of ethics held up for the admiration of the car department.

MR. BETTS: They have nothing to do with the distribution of cars.

THE PRESIDENT: If there is no further discussion, Prof. Dewsnup will close.

PROF. DEWSNUP: I do not know that I can attempt to reply to all the points that have been raised, but I may say in referring to shop facilities your speaker intended to cover the whole question of the organization of repair work and not merely the number of shop buildings. I may say that the figures that I based my remarks upon were taken from the returns of the committee on car efficiency, and while a number of roads do show very excellent performance, there are other roads that show a performance so much the reverse that it cannot help but attract attention.

One can understand, of course, the percentage of cars in shops increasing considerably, during the slack season, being a suitable period for the execution of repairs, but when one sees a road persistently maintaining a high percentage, in some cases, I think, 10 to 15 per cent of the equipment of the road, it would look as though there was something wrong with the management of the business. I have not attempted to assign causes, but simply to point out the fact as one that attracts the attention of the students of these matters. I heartily agree, as indicated in the paper, with the position taken by Mr. Hennessey with reference to the attitude of a number of the shippers to the railroad and its equipment. The thesis of my paper has been, I think, that really the roads seem to have provided equipment corresponding with the increase of business. The debatable point is whether one would not have expected to see as a result of increased skill in handling operating matters, emphasized by one of those taking part in the discussion, an improvement in the car mileage situation. Is marking time the best that can be done?

I was hoping that some of the members of the Club would have taken up questions that I have only been able to touch upon more

or less hypothetically, the influence, for instance, of private car ownership, and operation upon mileage averages. Undoubtedly on some roads, such conditions exert much more powerful influence upon operating averages than in others.

It would be interesting to know from the leading railroads of the country whether the increase of their coal ton-mileage and car mileage has kept pace *pari passu* with the increase of their general ton-mileage and car mileage: whether private cars operated on their lines have increased at the same rate as railroad owned cars, or, if not, at what rate? Information along these lines would enable a better estimate to be made of the individual performance of any particular road over a determined series of years than is possible with the inadequate statistics usually presented to us through the medium of the annual reports.

A great deal has been said about the obstacles standing in the way of making any great advance in car mileage. I realize this very fully, but in so far as railroads have overcome great obstacles in other respects, it is just possible that they can overcome these, including under this head an equitable adjustment of relations with shippers, as well as the economical adjustment of internal organization. I have not been able to dwell upon the question of shippers' delays, but it is obviously one requiring considerable attention in any movement directed towards improved conditions of operation.

The President: Before we adjourn, I believe the Secretary has an announcement to make in reference to the next meeting.

The Secretary: The first order of business at our May meeting will be the election of officers. After that we will have some discussions which will be entertaining and instructive, and the members who fail to attend will miss a good thing. The program is not fully completed, but arrangements are being effected which indicate an enjoyable meeting. That is all I have to say, Mr. President.

The President: If there is nothing further, adjournment is in order.

Adjourned.

The David L. Barnes Library

SPECIAL NOTICE.

The David L. Barnes Library of this Club, at 390 Old Colony Bldg., Chicago, is open for the use of members and their friends, and we hope it will be used freely. It is open on week days from 9 a. m. to 5:30 p. m., except on Saturday, until 3 p. m. Books must not be removed from Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The annual meeting of the Western Railway Club was held at the Auditorium Hotel, Friday evening, May 29, 1908. President C. A. Seley in the chair. The meeting was called to order at 8 P. M. The following members registered:

Adams, C. E.
Ames, C. F.
Axtell, G. F.
Baker, F. L.
Ball, A. L.
Barbee, B. C.
Barnes, C. A.
Barnum, M. K.
Barton, T. F.
Bement, A.
Bourne, G. L.
Brown, S. D.
Bryan, L. H.
Brown, G. H.
Bryant, G. H.
Buckbee, E. J.
Buckingham, C. L.
Buell, D. S.
Calahan, J. P.
Cameron, F. C.
Chadwick, A. B.
Chapman, A. J.
Cunningham, J. B.
Curtis, J. J.
Dangel, W. H.
Delaney, A. G.
DeMoss, Ira
Derby, W. A.
Dow, G. N.
Edwards, F. W.
Endsley, L. E.
Eames, E. J.
Fantom, W. F.
Flavin, J. T.
Forsyth, Wm.
Fosdick, F. C.
Fowler, W. E. Jr.
Fromm, A. B.
Graves, R. I.
Gardner, J. E.
Garrett, C. M.
Gear, R. B.
Gibson, J. A.
Goodnow, T. H.
Hahn, F. W.
Hatch, H. B.
Henderson, T. D.
Hincher, W. W.
Hinds, J. B. L.
Hopkins, G. H.
Holmes, S. E.
Harkness, F. L.
Haynes, J. R.
Hull, G. A.
Hibbard, M. W.
Hildreth, F. F.
Jett, E. E.
Jones, L. E.
Keeler, Sanford
Kelley, H. D.
King, C. H.
Kleeman, Chas.
Krau, Chas.
Kucher, T. N.
LaRue, H.
Lewis, J. H.
Lickey, T. G.
Little, J. C.
Lowder, R. S.
McAlpine, A. R.
Macfarland, W.
Maher, J. T.
Marsh, H. M.
Martin, P. A.
Maus, N. R.
Midgley, S. W.
Monroe, M. S.
Moody, W. O.
Morris, W. S.
Motherwell, J. W.
Mullen, J. R.
Murray, John
Nathan, C. A.
Neff, J. P.
Park, H. S.
Passmore, H. E.
Peck, C.
Phipps, D. L.
Price, R. C.
Ristine, J. D.
Robb, J. M.
Royal, Geo.
Schlacks, W. J.
Schlegell, F. von
Schroyer, H. H.
Seaberg, F.
Seley, C. A.
Sharp, W. E.
Shaver, M. E.
Shumate, F. D.
Slagle, R. E.
Slaughter, G. F.
Slaughter, H. W.
Smith, Robt.
Smith, W. R.
State, R. E.

Stearns, R. B.	Thomas, A. R.	Willcoxson, W. G.
Stott, A. J.	Towsley, C. A.	Woods, E. S.
Taft, R. C.	True, C. H.	Wright, Wm.
Tawse, W. G.	Walsh, A. F.	Young, C. B.
Taylor, E. D.	Warner, H. E.	Younglove, J. A.
Taylor, J. W.	Webb, E. W.	Younglove, J. C.
Tetlow, G. W.	Widner, J. E.	Zealand, T. H.

THE PRESIDENT: The first business is the approval of the minutes of the last meeting, which have been printed and distributed. Unless objection is made they will stand approved.

The next business is the report of the Secretary.

THE SECRETARY: Mr. President, I have the usual membership statement. The membership at the April meeting, as you all know, reached the high water mark of 1,500. During the month we have received applications as follows:

NEW MEMBERS.

Name Occupation Address	Proposed by
R. P. Zint, Republic Iron & Steel Co., Chicago	Tom Plunkett W. O. Duntley
L. Wilber Crane, Republic Iron & Steel Co., Chicago	Tom Plunkett W. O. Duntley
Chas. E. Foyle, M. M. Susqua New York R. R., Towanda, Pa	J. W. Taylor
J. P. Cummings, Supt. Beardstown Div., C. B. & Q. R'y., Kansas City, Mo	M. K. Barnum
Harry W. Finnell, Ch'ga R'y Equipment Co., Chicago	E. F. Leigh
C. H. Williams, Jr., Ch'go. R'y Equipment Co., Chicago	E. F. Leigh
Chas. Markel, Foreman C. & N. W. R'y., Clinton, Ia	F. G. Benjamin
G. E. Ryder, Ass't. Smoke Insp. Health Dept., Chicago	J. W. Taylor

RESIGNATIONS.

W. T. Williams G. R. Parker T. L. Condron
F. V. Whiting A. N. Wilsie

Membership, April, 1908	1,500
New members approved by Board of Directors	8
	1,508
Resignations	5
Total membership	1503

THE PRESIDENT: The next business will be the report of the Secretary for the year.

THE SECRETARY: Mr. President, I have the following annual report:

To the President and Board of Directors of the Western Railway Club:

MEMBERSHIP.

Membership April, 1907		1,387
Resigned	57	
Deaths	2	
Dropped for various reasons	32	91
		1,296

New members admitted during the year ending April, 1908....203		
Reinstated	1	204
Total membership..		1,500

The following is a list of those taken from the membership list for various reasons:

NON-PAYMENT OF DUES.

F. G. Howland, Shop For., B. & M. R. R., Havelock, Neb.
R. K. Peirce, Spec. Appr., C., B. & Q. Ry., Burlington, Ia.
F. H. G. Albrecht, Asst. Foreman, C. & E. I. R. R., Chicago.
G. M. Bean, A. T. & S. F. Ry., Chicago.
H. A. Brimley, M. P. Dept. Penna., Ft. Wayne, Ind.
G. T. Briggs, Quincy, Manchester-Sargent Co., Chicago.
C. P. Burgman, Chgo. Ind. & Louisville, Hammond, Ind.
R. T. Farrell, Ill. Southern Ry., Sparta, Ill.
Wm. Grady, Trav. Engr. E. T. & E. R. R., Joliet, Ill.
J. A. Hill, Los Angeles, Cal.
A. T. Herr, Amer. B. S. & F. Co., Denver, Colo.
K. D. Hequenbourg, Franklin Ry. Supply Co., Franklin, Pa.
C. W. Kelley, Supt. B. & B., C. & N. W. Ry., Boone, Ia.
O. C. Mann, Young-Mann-Averill Co., Chicago.
C. A. Lichty, C. & N. W. Ry., Chicago, Ill.
E. P. Marsh, C. & N. W. Ry., Chicago, Ill.
C. W. Martin, Consol. Car Heating Co., Chicago, Ill.
W. F. McCormick, Chicago, Ill.
W. J. McLeish, S. M. P. E. & T. H. R. R., Evansville, Ind.
W. K. Millholland, Gisholt Mfg. Co., Chicago, Ill.
J. H. Van Buskirk, 610 Grand Central Station, New York.
J. B. Allfree, 1446 Wilson Ave., Chicago.
F. P. Barnes, Grand Junction, Colorado.
Stanley Woodworth, 100 Lake St., Chicago.
M. H. Wilkins, Grand Island, Nebraska.
F. G. Whipple, Old Colony Bldg., Chicago.
A. W. Wheatley, American Locomotive Works, New York.
S. S. Voorhees, Washington, D. C.
F. E. Smith, Elkhart, Ind.
A. M. Smith, Detroit, Mich.
E. G. Rost, Baltimore, Md.
H. O. Westmark, Aurora, Ill.

RESIGNED.

W. D. Sargent, Amer. Brake Shoe & Fdy. Co., New York.
J. F. Ryan, N. Y. C. & St. L. R. R., Chicago.
E. D. Edgerton, Care C. R. I. & P. Ry., New York.
E. G. Busse, Care Illinois Central R. R., Chicago.
H. A. Fergusson, Care J. T. Ryerson & Son, St. Louis.
W. H. Corbett, T. M. Mich. Central R. R., Jackson, Mich.
Thos. Jackson, Care Mech. Rubber Co., Redlands, Cal.
R. H. Soule, Boston, Mass.
G. M. Nisbett, Chicago.
J. F. Fleischer, M. M. C. & N. W. Ry., Sioux City, Ia.
W. H. Stare, Advance Construction Co., Waukesha, Wis.
E. L. Burdick, Insp. Tests Wabash R. R., Springfield, Ill.

C. W. Spencer, Can. Pac. Ry., Montreal, Can.
B. H. Hawkins, Gold Car Heating Co., New York.
H. C. Pearce, G. S. K. So. Pac. Co., San Francisco.
J. B. Barnes, S. M. P., Wabash R. R., Springfield, Ill.
D. E. Bonner, The Pantasote Co., Chicago, Ill.
J. S. Bridges, Economy Loco. Sander Co., Baltimore, Md.
C. E. Cardeu, Thos. Cook & Co., London, England.
F. C. Carrill, Jacksonville, Ill.
Jas. Dickson, G. F., C., B. & Q. Ry., Quincy, Ill.
Kuno von Eltz, R. H. F., Mich. Cent. R. R., Michigan City, Ind.
C. D. Ettenger, Murphy Varnish Co., Chicago.
G. W. Farmer, Foreman, A. T. & S. F. Ry., Ft. Madison, Ia.
T. P. Felix, Latrobe Steel & Coupler Co., Melrose Park, Ill.
Chas. Hankole, Foreman, C. & N. W. Ry., Eagle Grove, Ia.
C. F. Heywood, Latrobe Steel & Coupler Co., Melrose Park, Ill.
F. C. Kneller, G. F., C., M. & St. P. Ry., Milwaukee, Wis.
C. E. Leach, New York Air Brake Co., New York, N. Y.
W. S. McKee, American Brake Shoe & Fdy. Co., Chicago.
David Meadows, Trav. Engr., Mich. Cent. R. R., St. Thomas, Ont.
C. M. Mendenhall, American Steel Foundries, New York City.
W. H. Myers, Latrobe Steel & Coupler Co., Melrose Park, Ill.
F. D. Palmer, Loco. Engr., C., B. & Q. Ry., Lincoln, Neb.
J. A. Peabody, Signal Engr., C. & N. W. Ry., Chicago.
H. F. Schumacher, C. C. Trans., C. L. S. & E. Ry., Chicago.
G. E. Van Wort, Murphy Varnish Co., Chicago.
H. D. Webster, Bayonne, N. J.
J. A. Whaling, Milwaukee, Wis.
F. H. Wilson, Asst. Supt., L. S. & M. S. Ry., Chicago.
Jas. G. Mowry, Patton Paint Co., Newark, N. J.
J. D. Young, Mach. Shop Foreman, C., B. & Q. Ry., Havelock, Neb.
G. A. Richardson, C. M. & St. P. Ry., Chicago, Ill.
B. J. Sweatt, C. & N. W. Ry., Boone, Ia.
F. M. Gilpin, Latrobe Steel Coupler Co., Chicago.
Geo. Ackerman, Solid Steel Tool & Forge Co., Chicago, Ill.
C. C. Winegardner, L. S. & M. S. Ry., Elkhart, Ind.
J. A. Mullin, C. & N. W. Ry., Norfolk, Neb.
M. E. Wallace, Westinghouse Air Brake Co., Hamilton, Ont., Can.
W. W. Ricker, Guarantee Construction Co., New York.
Mehrle Middleton, Standard Steel Works, Chicago.
Burton R. Stare, Peckham Mfg. Co., Chicago.
Thos. T. Doran, C. B. & Q. Ry., Burlington, Ia.
Ben Johnson, S. M. P. Mex. Central Ry., Aguascalientes, Mex.
Geo. Espey, Signal Engr., C. & W. I. R. R., Chicago, Ill.
E. B. Farmer, Westinghouse Air Brake Co., St. Paul, Minn.
John Conrath.

REINSTATED.

A. M. Smith, Detroit, Mich.

DEAD.

J. P. Brown, Loco. Engr. C. N. O. & T. P. Ry., Somerset, Ky. Died February, 1906.
Prof. Storm Bull, University of Wisconsin, Madison, Wis.

The following is a list of new members during the year:

NAME. ADDRESS.	PROPOSED BY
E. B. Hughes, Mech. Dept. Wabash R. R., Paterson, N. J.	B. H. Jeffries
J. T. Markham, Sellers' Mfg. Co., Chicago	E. M. Kerwin
H. J. Green, Chicago Varnish Co., Chicago	O. H. Morgan
G. N. Saum, Car Foreman, C. & W. I. R. R., Chicago.	P. H. Peck
H. J. Kessler, Draftsman C., B. & Q. Ry., Lincoln, Neb.	Thos. O'Neal
W. F. Hall, Spec. App. L. S. & M. S. Ry., Collinwood, Ohio	I. S. Downing
R. C. Raines, R. H. F. Norfolk & Western Ry., Williamson, W. Va	D. G. Cunningham
H. E. Dickerman, Yale & Towne Mfg. Co., New York City	G. A. Stone
P. M. La Bach, Draftsman, C. R. I. & P. Ry., Chicago.	A. K. Shurtleff
J. J. Barry, G. F. N. & W. Ry., Roanoke, Va	D. G. Cunningham
C. E. Thomas, G. F. Ill. Central R. R., Chicago	J. W. Motherwell
E. J. Buckbee, Mach. Foreman C. C. C. & St. L. Ry., Urbana, Ill	J. C. Thorpe
LeRoy S. Wright, Salesman Natl. Mall. Castgs. Co., Chicago, Ill	J. H. Jaschka
G. H. Davison, 2nd V. P. Beckwith-Chandler Co., New York	W. L. Crossman
W. T. McKee, Piece Work Insp. L. S. & M. S. Ry., Collinwood, Ohio	I. S. Downing
D. E. Gardner, R. F. E. Norfolk & Western Ry., Portsmouth, Ohio	D. G. Cunningham
J. A. Baldwin, Repr. Berlin Mach. Wks., Chicago, Ill.	Thos. Plunkett
W. E. Wunderlick, Eng. House Foreman Penna. Co., Chicago, Ill	W. E. Sharp
H. E. Tucker, N. Y. Air Brake Co., Chicago, Ill	J. W. Taylor
Christopher Day, Car Foreman So. Side Elevated Ry.	G. H. Hopkins
Thos. C. Eayrs, Engr. Westinghouse E. & M. Co., Chicago, Ill	G. H. Hopkins
G. W. Hanaur, Supt. C. I. & S. Ry., Hammond, Ind.	W. E. Sharp
F. G. Colwell, Shop Foreman I. C. R. R., Chicago	G. M. Crownover
G. D. Bassett, Crerar Adams & Co., Austin, Ill	H. T. Bentley
C. E. Mohle, Specialist C. & N. W. Ry., Oak Park, Ill.	H. T. Bentley
W. P. Steele, American Loco. Co., New York	C. A. Seley
Edgar Lewis, Westinghouse Mach. Co., Chicago	A. B. Johnson
W. M. Perry, Elect. C. & W. I. R. R., Chicago	P. W. Pick
R. W. Rustuholz, Ingersoll Rand Drill Co., Chicago	L. E. Ensley
Geo. Cooper, Frost Ry. Supply Co., Detroit	C. A. Seley
Chas. W. Peterson, C. D., Engr. Dept., Rock Island R. R., Chicago	A. K. Shurtleff
Geo. N. Boyd, West. Repr., Pantasote Co., Chicago	D. E. Bonner
Anthony Saddler, For. Boiler Maker, C. & N. W. Ry., So. Kaukauna, Wis	S. C. Graham
W. F. Carroll, Rd. For. of Engines, C. & N. W. Ry., Waseca, Minn	W. E. Dunham
T. T. Cavanaugh, Scully Steel & Iron Co., Chicago	W. H. Dangel
F. C. Shafer, G. F., N. Y. C. & St. L. Ry., Chicago	Geo. James
L. W. Barber, Standard Car Truck Co., Chicago	J. C. Barber
G. S. Chiles, Spec. Appr., L. S. & M. S. Ry., Collinwood, Ohio	G. W. Bissell
G. L. Dolan, Engineer, C. & E. I. Ry., Chicago	W. G. Tawse
C. W. Gennet, Jr., Atha Steel Castings Co., Chicago	G. C. Isbester

NAME. ADDRESS.	PROPOSED BY
O. C. Hayward, Sec'y, Towsey Varnish Co., Chicago	R. B. Kadish
W. A. Jones, Penna. R. R., Ft. Wayne, Ind	D. F. Crawford
R. C. Price, C. I. & S. Ry., Gibson, Ind	S. T. Rowley
G. N. Sweringen, Mgr. Sales, McMaster-Carr Supply Co., Chicago	J. W. Motherwell
W. H. Winterrowd, Spec. Appr., L. S. & M. S. Ry., Elkhart, Ind	A. R. Ayers
H. A. Gardner, Elec. Engr., C., B. & Q. Ry., Chicago	C. B. Young
G. H. Rice, City Electrician, Chicago, Ill	P. H. Peck
R. W. Stephens, Train Master, Belt Ry., Chicago	P. H. Peck
P. T. Dunn, M. M., Penna. Lines, Chicago	P. H. Peck
Wm. V. McNamara, Car For., Williamson, W. Va	D. G. Cunningham
E. P. Gould, Chicago Bailey Co., Chicago	H. T. Bentley
J. R. Davies, A. P. A., Chicago City Ry., Chicago	W. W. Hincher
T. G. Averill, Marvin Mfg. Co., Franklin, Pa	C. B. Holdrege
M. Yoshino, Supt. R. S., Manchurian Ry., Tairen, Manchuria	C. M. Muchnic
Y. Yamamoto, Mech. Engr., Manchurian Ry., Tairen, Manchuria	C. M. Muchnic
Olaf Anderson, Draftsman, C. & N. W. Ry., Chicago	T. E. Warnock
R. S. Lowder, Draftsman, C. & N. W. Ry., Chicago	J. C. Little
L. P. Michael, Draftsman, C. & N. W. Ry., Chicago	J. C. Little
M. E. Towner, C. C. to V. P., C., R. I. & P. Ry., Chicago	C. A. Seley
J. L. Berman, Northwestern Elev. R. R., Chicago	C. A. Seley
A. J. Ashton, C. C. Supt. Tel., C. & E. I. R. R., Chicago	F. H. Rutherford
L. W. Wallace, Instructor, Purdue University, Lafayette, Ind	L. E. Endsley
W. S. Furry, Ohio Injector Co., Chicago	F. W. Furry
G. W. Seidel, Supt. Shops, C., R. I. & P. Ry., Silvis, Ill.	C. A. Seley
Chas. H. Johnson, G. F., Loco. Dept., Mich. Cent. R. R., Chicago	E. R. Webb
C. L. DeMuralt, Muralt & Co., New York, N. Y	Chas. Ducas
F. A. Lawler, Crucible Steel Co., Chicago	F. Baskerfield
W. N. Connor, Gen. Inspr., C. & E. I. R. R., Chicago	H. H. Estrup
C. Stanley Sale, Railway Age, Chicago	Wm. Forsyth
E. H. Ward, Sec'y & Treas. Memphis Car Co., Memphis, Tenn	R. B. Kadish
W. A. Simms, Genl. Supt. Memphis Car Co., Memphis, Tenn.	R. B. Kadish
W. H. Heckman, Special Inspector, C., B. & Q. Ry., Chicago, Ill	C. B. Young
C. L. Woodruff, Tousey Varnish Co., Chicago, Ill	A. E. Goodhue
F. W. Hahn, Rodger Ballast Car Co., Chicago, Ill	Swen Holmes
R. S. Faragher, Sec'y & Treas. Blue Island Car & Equipment Co., Chicago, Ill	J. W. Taylor
F. W. Marquis, Instructor, Ry. Eng. Dept. U. of I., Urbana, Ill	E. C. Schmidt
F. W. Graves, Scullin-Gallagher Iron & Steel Co., Chicago, Ill	A. B. Johnson
L. W. Sawyer, New York Air Brake Co., Chicago, Ill.	H. E. Tucker
W. L. Ehrich, Supt. Bonanza Belt Copper Co., Johnson, Ariz	J. W. Taylor

NAME. ADDRESS.	PROPOSED BY
S. G. Down, Westinghouse Air Brake Co., Chicago, Ill.	C. C. Farmer
R. B. Fulks, Water Inspector, C., B. & O. Ry., Aurora, Ill.	G. H. Hill
G. C. Denny, Mch. Asst. Laboratory, C., B. & O. Ry., Aurora, Ill.	G. H. Hill
C. L. Ransom, Res. Engr. C. & N. W. Ry., Omaha, Neb.	A. K. Shurtleff
H. H. Scovil, Railway Steel Spring Co., Chicago, Ill.	N. C. Naylor
H. E. Davis, Engr. C., M. & St. P. Ry., Ladd, Ill.	L. M. Addleman
E. H. O'Neil, Asst. to Genl. Supt. M. & N. E. R. R., Manistee, Mich.	W. H. Nuttall
Wm. Fair, Genl. Foreman C., B. & Q. Ry. Shops, Hannibal, Mo.	J. W. Cyr
J. M. McCarthy, C. C. to Genl. Pur. Agt., Rock Island & Frisco Road, Chicago, Ill.	C. A. Seley
Richard Gear, Armour Car Lines, Chicago, Ill.	W. E. Sharp
J. S. Lauby, Shop Instructor L. S. & M. S. Ry., Elkhart, Ind.	C. A. Towsley
F. C. Fosdick, A. M. M., C. & N. W. Ry., Chicago, Ill.	W. R. Smith
W. T. Gale, Foreman C. & N. W. Ry., Chicago, Ill.	W. R. Smith
F. J. O'Rourke, G. F., C. I. & S. R. R., Gibson, Mo.	J. T. Flavin
H. L. Osman, S. C. D., Morris & Co., Chicago, Ill.	M. M. Vincent
John Troy, Foreman Boiler Shop P. M. R. R., Saginaw, Mich.	S. L. Moffitt
F. R. Austin, Auditor, E. & T. H. R. R., Evansville, Ind.	E. H. DeGroot, Jr.
H. O. McClain, Draftsman, I. C. R. R., Chicago, Ill.	G. F. Axtell
J. H. Houck, Supt. Hamler Boiler & Tank Co., Chicago, Ill.	W. E. Sharp
J. R. Hamilton, Draftsman Armour & Co., Chicago, Ill.	W. E. Sharp
A. W. Clement, Sales Agt. Ohio Brass Co., Mansfield, Ohio	C. H. Fry
Carl Penner, Standard Metal Mfg. Co., Chicago, Ill.	D. C. Barber
W. T. Sherman, U. S. Lighting & Heating Co., Chicago, Ill.	H. E. Tucker
Geo. Kleifgen, N. Y. Air Brake Co., Chicago, Ill.	H. E. Tucker
J. E. Forsyth, Forsyth Auto. Air & Steam Coupler Co., Chicago, Ill.	H. E. Tucker
C. P. Lovell, N. Y. Air Brake Co., Chicago, Ill.	H. E. Tucker
W. F. Bowers, Ill. Central R. R., Chicago, Ill.	H. E. Tucker
M. B. Lambert, Engr. Westinghouse B. & M. Co., Chicago, Ill.	G. H. Hopkins
A. J. Chapman, C. C. Shop Acct. C. I. & S. R. R., Hammond, Ind.	J. B. L. Hinds
Eugene McAuliffe, Genl. Fuel Agt. Rock Island Lines, Chicago	W. E. Symons
R. B. Clark, Scullin-Galagher Iron & Steel Co., Chicago	E. H. Walker
M. E. Wise, The Railway Age, Chicago	E. H. Walker
W. F. Bleecker, Prest. Universal Mfg. Co., Boulder, Colo.	J. W. Taylor
G. W. Beebe, Wheel Inspector C., B. & Q. Ry., Aurora, Ill.	S. D. Brown
H. U. Morton, V. P. Natl. Mfg. & Supply Co., Chicago	H. H. Shroyer
A. J. Odegaard, Pur. Dept. Rock Island Lines, Chicago	Carter Blatchford

NAME.	ADDRESS.	PROPOSED BY
C. J. Pilliod, G. F. T., St. L. & W. R. R., Frankfort, Ind.		R. J. McGrail
C. W. Clements, Inspector C., B. & Q. Ry., Aurora, Ill.		G. H. Hill
L. A. North, Mach. Shop Foreman Ill. Cent. Ry., Chicago		F. G. Colwell
A. M. Sheffer, Atlantic Equipment Co., Chicago		J. H. Wynne
E. B. Reynolds, C. C. to Supt. Tel. Ill. Cent. Ry., Chicago		E. Parsons
H. S. Mored, R. E., C., B. & Q., Ottumwa, Ia.		I. N. Funk
C. S. Parker, Sec'y Parker Car Heating Co., Detroit, Mich.		G. H. Bryant
H. A. Johnson, Engr. Car Equipment Met. W. S. Ele. Ry., Chicago		E. T. Munger
Harry Barnard, Draftsman, Armour & Co., Chicago		W. E. Sharp
Roy Cresse, C. C., C. R. I. & P. Ry. Store Dept., Chicago		C. L. Buckingham
W. C. Scofield, F. B., I. C. R. R., Chicago		G. M. Crownover
Hugh Bartlett, Clerk Wabash R. R., Chicago		J. E. Gardner
J. J. Ellis, Supt. M. P., C. St. P. M. & O. Ry., St. Paul, Minn.		J. W. Taylor
H. E. Culbertson, M. M., C., B. & Q. R. R., McCook, Neb.		J. W. Chase
C. E. Emerson, Car Foreman, C., B. & Q. R. R., McCook, Neb.		J. W. Chase
A. H. McLean, Air Brake Inspector, Urbana, Ill.		S. J. Kidder
H. B. Ketzle, Natl. Dump Car Co., Chicago, Ill.		H. A. Bowen
P. A. Martin, Natl. Car Line Co., Chicago, Ill.		M. M. Vincent
T. A. Eselmann, Engr. Dept. Indiana Steel Co., Chicago		T. B. Cram
Jas. J. Elliott, Sec'y Nashville Carbon & Oil Co., Chicago, Ill.		T. H. Sweringen
Chester N. Stevens, Asst. Mgr. Barrett Mfg. Co., Chicago, Ill.		J. R. Cardwell
L. E. Nelson, Pur. Dept. C. M. & St. P. Ry., Chicago.		Carter Blatchford
E. H. Doherty, M. M., Panama Canal, Corozal, Canal Zone		F. E. Delano
M. T. Lightner, Mech. Dept. C. & A. Ry., Bloomington, Ill.		G. H. Hopkins
F. C. Sorenson, Foreman Armour Car Lines, Chicago, Ill.		W. E. Sharp
Chris. Anderson, G. C. F., C. R. I. & P. Ry., Chicago, Ill.		C. L. Buckingham
J. C. Campbell, Chgo. Pneumatic Tool Co., Chicago, Ill.		C. J. Albert
L. A. Hopkins, Chgo. Pneumatic Tool Co., Chicago, Ill.		C. J. Albert
Frank Sherrett, Imperial Car Cleaner Co., Chicago, Ill.		J. J. Hennessey
W. H. Colton, M. E., Chicago, Ill.		G. H. Bryant
Andrew Speirs, Amer. Car & Fdy. Co., Chicago, Ill.		J. R. Cardwell
W. P. Waugh, Variety Mfg. Co., Chicago, Ill.		C. L. Dinsmore
T. H. Bronson, Engr. C. & W. I. Ry., 83rd St. Shops, Chicago, Ill.		P. H. Peck
W. A. DeMoss, Mach. L. S. & M. S. Ry., Chicago, Ill.		E. D. Taylor
Oscar F. Ostby, Sales Mgr. Commercial Acetyline Co., New York		G. H. Bryant
Edmund W. Tetlow, Salesman, Western Tube Co., 922 Marquette Bldg., Chicago		G. M. Crownover

NAME. ADDRESS.	PROPOSED BY
R. W. Schulze, Genl. Car Foreman G. C. & S. F. Ry., Cleburne, Tex.	J. E. Epler
Chas. H. Benjamin, Dean. Eng. Schools, Purdue University, Lafayette, Ind.	L. E. Endsley
J. F. Whiteford, Gen. R. H. Insp. A. T. & S. F. Ry., Albuquerque, N. M.	J. E. Epler
F. C. Cameron, Draftsman, Natl. Dump Car Co., Railway Exchange, Chicago	H. B. Hatch
J. W. Snead, M. E. Gravity Coal Bin Co., Railway Exchange, Chicago	H. B. Hatch
D. Walker Wear, Storekeeper, C. I. & S. R. R., 4201 Ellis Ave., Chicago	W. McMaster
E. H. Landers, Storekeeper, L. S. & M. S. Ry., Chicago	W. McMaster
P. C. Cady, L. S. & M. S. Ry., Cleveland, Ohio	G. N. Dow
Edwin F. Leigh, Repr. Chicago Railway Equipment Co., Chicago	W. B. Hall
Clifford A. Nathan, Nathan Mfg. Co., Chicago	Sanford Keeler
J. W. Dalman, Latrobe Steel & Coupler Co., Chicago	J. W. Taylor
C. J. Albert, Mgr., Cleveland Pneumatic Tool Co., Cleveland, Ohio	J. G. Talmage
W. C. Talmage, Ry. Steel Spring Co., Cleveland, Ohio	J. G. Talmage
J. T. Maher, American Steel Foundry, Chicago	H. T. Bentley
W. F. Buck, Mech. Supt. A. T. & S. F. Ry., Topeka, Kan.	W. L. Allison
C. W. Pflager, Asst. Mech. Supt. Pullman Co., Chicago	M. K. Barnum
T. H. Garland, Gen. Agt. Repr. Service C., B. & Q. Ry., Chicago	M. K. Barnum
G. T. Cooke, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
Carl S. Clingman, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
W. R. Hungerford, Mech. Insp. Pullman Co., Chicago	L. S. Hungerford, Jr.
Roswell P. Cooley, Mech. Insp. Pullman Co., Chi.	L. S. Hungerford, Jr.
Wm. Rourke, Gen. Car Foreman, A. T. & S. F. Ry., Chicago	C. C. Higgins
J. B. Cunningham, C. C., A. T. & S. F. Ry. Shops, Chicago	C. C. Higgins
G. A. Schneider, Standard Steel Car Co., Hammond, Ind.	W. A. Libkeman
A. W. Adams, Allen & Morrison Brake Shoe Co., Chicago	G. N. Sweringen
E. W. Webb, M. E. Standard Car Truck Co., Chicago, Ill.	Lee W. Barber
F. T. Dickinson, Amer. Brake Shoe Fdy. Co., Chicago, Ill.	C. L. Sullivan
D. M. Brady, Prest. Brady Brass Co., New York, N. Y.	G. H. Bryant
L. I. Yeomans, Insp. Armour & Co., Chicago, Ill.	W. E. Sharp
W. B. Moulton, Insp. C. M. & St. P. Ry., Evanston, Ill.	J. P. Neff
E. L. Gibbs, Inspector Interstate Commerce Commission, Ft. Worth, Tex.	D. C. Buell
C. B. Hoyt, Supt. Track Maintenance & Construction, N. Y. C. & St. L. Ry., Bellevue, Ohio	G. N. Dow
A. W. Bowman, Genl. Yard Master, C. & E. I. R. R., Chicago, Ill.	F. H. Rutherford
Wm. Jappert, Car Foreman, C., B. & Q. Ry., Lincoln, Neb.	Wm. Baird

NAME. ADDRESS.	PROPOSED BY
I. W. Darby, Mather Stock Car Co., Chicago, Ill.	W. B. Hall
R. S. Alsdorf, Draftsman, C. R. I. & P. Ry., Chicago, Ill.	G. S. Goodwin
C. L. Buckingham, Draftsman, C. R. I. & P. Ry., Chicago, Ill.	G. S. Goodwin
Chas. Kleeman, Draftsman, C. R. I. & P. Ry., Chicago, Ill.	G. S. Goodwin
J. O. Neikirk, Rodger Ballast Car Co., Chicago, Ill.	Carter Blatchford
H. L. Cole, Sales Mgr. Bradford Draft Gear & Mfg. Co., Chicago, Ill.	M. K. Barnum
W. A. Stearns, M. E. L. & N. R. R., No. Louisville, Ky.	F. W. Fenn
A. F. Walsh, Draftsman, Ill. Central R. R., Chicago, Ill.	G. F. Axtell
O. M. Olson, Spencer Otis Co., Chicago, Ill.	Carter Blatchford
C. J. Humphreys, Spencer Otis Co., Chicago, Ill.	Carter Blatchford
C. F. Leppla, Draftsman, C. R. I. & P. Ry., Chicago, Ill.	G. S. Goodwin
R. I. Graves, Spec. App., C. & N. W. Ry., Chicago, Ill.	H. D. Kelley
J. Soule Smith, Amer. Steel Fdrs., Chicago, Ill.	D. T. Harris
J. R. Stuart, Amer. Steel Fdrs., Chicago, Ill.	D. T. Harris
Clive Runnells, McCord & Co., Chicago, Ill.	W. J. Schlacks
Jas. H. Delaney, Western Elect. Co., Chicago, Ill.	Percival Hunter
Jno. I. Dewar, Spec. App., C. & N. W. Ry., Chicago, Ill.	H. D. Kelley

FINANCIAL.

From the Treasurer's books the following details of receipts and expenses are taken:

RECEIPTS.

Balance on hand May 21, 1907		$1,735.11	
Receipts from all sources		5,284.79	
Total receipts			$7,019.90

EXPENSES.

Binding annual proceedings		431.40	
Cost of advertisements		558.18	
LIBRARY:—			
Salary Librarian	$140.00		
Insurance	16.80		
Rent Library room	381.00		
Incidentals	287.50		
		825.30	
Office expenses		292.13	
Postage		544.82	
Printing		1,929.59	
Reporting proceedings		220.90	
Salary Secretary		300.00	
Total expenses			$5,102.32
Balance on hand			$1,917.58

The only indebtedness the club has is shown by the bills approved by the Board of Directors today, amounting to $784.50.

The bills receivable are as follows:

From advertising	$1,360.41
From annual dues—$4.00	340.00
From annual dues—$2.00	444.00
From sale of proceedings	
Total	$2,144.41

The assets of the club, in so far as available funds are concerned, can be estimated about as follows:

From advertising	$1,360.41
From payment of dues, 25% off	588.00
Unappropriated balance	1,133.08
Total available assets	$3,081.49

Jos. W. Taylor,
Secretary.

The President: Next, we will have the Treasurer's report.

To the Officers and Members of the Western Railway Club:

I take pleasure in handing you my tenth annual report as Treasurer.

RECEIPTS.		PAID OUT.	
Cash on hand May, 1907	$1735.11	On orders	$ 457.86
Received from Secretary:		August	614.18
August 5	$ 391.25	September	852.89
August 10	516.00	October	426.05
August 29	551.00	November	425.02
September 17	206.75	December	483.69
October 15	413.00	January	490.13
November 18	225.55	February	510.28
December 17	545.75	March	589.08
January 20	427.75	April	253.14
February 18	377.25		
March 17	704.49		
April 21	406.50		
May 29	519.50		
Total	$7019.90		
Paid out	$5102.32		$5102.32
Cash on hand May, 1908			$1917.58

Peter H. Peck,
Treas.

The President: What is your pleasure, gentlemen, in regard to the report of the Treasurer and Secretary?

The President: Moved and seconded that the report of the Secretary and Treasurer be spread on the minutes, and referred to the Auditing Committee. All those in favor, signify by saying "aye." Contrary, "no."

Motion carried.

The President: The appointment of auditors for the examination of these accounts will be taken care of by the new directors elected tonight.

The trustees of the library have no further report to make, except one of progress. The indexing of the library has been going on for

some time; it has reached a very fair stage and the contents now of the library are available in convenient form for any one who wishes to consult the library on any subject. A more formal report will be incorporated in the printed proceedings of this meeting.

The next in order is the election of officers. The Secretary will please read the portion of the constitution relating to that. This was done.

THE PRESIDENT: Inasmuch as I cannot be accused of favoritism, not running for office, I will name a Rock Island and Lake Shore combination for collecting tellers, Mr. La Rue and Mr. Goodnow. And I will ask two of our honored past presidents to act as counting tellers, Mr. Manchester and Mr. Carney. That is a Burlington-Milwaukee combination. Will the collecting tellers please pass the ballots?

Please prepare an informal ballot for President of the Western Railway Club for the ensuing year.

While the tellers are counting the ballot for President, will you please prepare your ballots for First Vice President, and I would suggest for the saving of time at the table that the ballots be not folded.

The counting tellers reported result of ballot for President as follows: M. K. Barnum, 131; W. E. Sharp, 5; P. H. Peck, 2; Goodnow, 3; Thompson, 1; C. B. Young, 1; C. A. Seley, 1; blank, 2.

THE PRESIDENT: That is the informal ballot; the two candidates receiving the highest number of votes shall be voted on on the formal ballot.

MR. PECK: I make a motion that the Secretary cast the unanimous ballot of the club for Mr. Barnum as President.

THE PRESIDENT: It has been moved and seconded that the Secretary cast the ballot for Mr. Barnum as President.

THE PRESIDENT: All those in favor, please say "aye."

Motion carried unanimously.

THE SECRETARY: Mr. President, I have the pleasure of casting the ballot of the meeting for Mr. Barnum as President of the Western Railway Club for the ensuing year.

THE PRESIDENT: The tellers will please collect the ballots for the first Vice President.

While this vote is being counted, please prepare your ballots for Second Vice President.

Report of the counting tellers on result of ballot for First Vice President was as follows: W. E. Sharp, 108; J. F. DeVoy, 16; Goodnow, 9; H. La Rue, 3; six or eight scattering votes of one each.

MR. DEVOY: I move that the Secretary be instructed to cast the unanimous ballot of the Club for Mr. Sharp as First Vice President.

Seconded.

THE PRESIDENT: It has been moved and seconded that the Sec-

retary cast the unanimous ballot of the Club for Mr. Sharp as First Vice President. All in favor, signify by saying "aye."

Motion carried unanimously.

The Secretary: Mr. President, I have cast the ballot of the Club for Mr. Sharp as First Vice President.

The President: The tellers will please collect the ballot for Second Vice President.

The Secretary: You have now elected Mr. Barnum, who was First Vice President, as President; Mr. Sharp, who was Second Vice President, as First Vice President. I might say that the members of the old board of directors are Mr. C. B. Young of the Burlington; Mr. George H. Bryant and Mr. J. F. DeVoy, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railway.

The President: While this ballot is being counted, we will arrange for the ballot for treasurer.

The report of the counting tellers on ballot for Second Vice President was as follows: J. F. DeVoy, 51; C. B. Young, 31; Goodnow, 19; W. O. Moody, 17; G. H. Bryant, 11, and scattering votes.

Moved by Mr. Squires that Mr. DeVoy be declared unanimously elected. Seconded.

The President: Moved and seconded that the Secretary cast the unanimous ballot of the Club for Second Vice President for Mr. DeVoy.

Motion carried.

The Secretary: I take pleasure in casting the unanimous ballot of the Club for Mr. DeVoy as Second Vice President.

Mr. Squires: We have just received a very fine report from our Treasurer, which shows 10 per cent increase in funds, I therefore would like to nominate the present incumbent of the office, Mr. Peter H. Peck, and I wish to make a motion that it is the sense of this meeting that nominations be closed and that the Secretary cast the unanimous ballot for Mr. Peter H. Peck for Treasurer.

The President: All those in favor, please say "aye." Contrary "no."

Motion unanimously carried.

The Secretary: I have cast the ballot for Mr. Peck.

The President: Mr. Peter H. Peck, you will please approach the bar. Mr. Peck, you are accused of taking such good care of the money of this Association that it never gets away, not only for the past year, but for ten years past. You are accused of being twenty-one years old in this Club and as an evidence of the appreciation of the Club, I have a small token to pass over the table. (Applause.)

Mr. Peck: Mr. President and Gentlemen of the Club, I hope that I may guard your funds for twenty-one years more. I thank you, I thank you all.

The President: Next in order will be the election of three members of the board of directors, which consists of the officers of

the Club, the President, Vice-Presidents, Treasurer and three members. What is your pleasure regarding the manner of casting this vote?

MR. W. S. MORRIS: Mr. President, realizing how anxious some of the candidates that have been elected are to express their thanks to the Club, in order to make the time as brief as possible between now and the expression of those gentlemen, I would move you, sir, that the ballot consist of three members as directors, instead of separating and voting for one on each ballot.

Motion seconded.

MR. PECK: Who are the members that will hold over?

THE SECRETARY: The directors last year were C. B. Young, George H. Bryant and Mr. J. F. DeVoy. Mr. DeVoy you have now elected as Second Vice President, so it will be necessary for you to vote for a new member.

MR. PECK: I would nominate Mr. Young, Mr. George Bryant and Mr. Goodnow.

Seconded.

THE PRESIDENT: There is a motion already before the house to vote for three members on one ballot. All those in favor please say "aye;" contrary, "no."

Motion carried.

MR. PECK: Now, Mr. President, I nominate Messrs. Young, Bryant and Goodnow if it is in order.

THE PRESIDENT: It has been moved and seconded that the ballot be cast for Mr. Young, Mr. Bryant and Mr. Goodnow as members of the Board of Directors. It has been moved further that nominations be closed. Are there any other nominations?

The question being called for, the motion was put to vote and unanimously carried.

THE PRESIDENT: The Secretary will please cast the ballot.

THE SECRETARY: Mr. President, I have cast the unanimous ballot of the Club for Messrs. Young, Bryant and Goodnow as members of the board of directors.

THE PRESIDENT: What is your pleasure regarding nominations for trustees of the library? The trustees now consist of F. W. Sargent, W. F. M. Goss and C. A. Seley.

MR. PECK: Mr. President, I move that the same directors be renominated.

Motion seconded.

THE PRESIDENT: Gentlemen, the motion, as I understand it, is that the Secretary be instructed to cast the unanimous ballot for the trustees of the library for Mr. Sargent, Mr. Seley and Prof. Goss. All in favor, please say "aye." Contrary, "no."

Motion carried unanimously.

THE SECRETARY: I cast the ballot as directed.

Mr. Peck: I move that the tellers be discharged with a vote of thanks.

Mr. Squires: Inasmuch as we appreciate what the tellers have done, I second that motion.

Motion put to vote and carried.

The President: While we are waiting for the Secretary to return, I would like to say one word of appreciation to the Club for the treatment which they have accorded the President and other officers this past year by attendance and attention and intelligent discussion of the papers that have been provided at the various meetings. I think that no Club in the country has had a higher order of talent displayed in their papers than we have had this past year, and we believe that this will go right along for another year without any difficulty at all, because it does not depend nearly as much on the officers as it does on the floor, and I bespeak for my successor a continuance of the kindly courtesy and good feeling that have been expressed to me during the past year.

I take very great pleasure in introducing to you your next President.

I will name Mr. Ross and Mr. Morris as a committee to escort the President-elect to the Chair.

President Barnum: Gentlemen, I want to thank you for the honor conferred by the election to the presidency of the Club and to ask your continued co-operation and I trust that we will keep up the good work that has been so well promoted during the past year under the generalship of our President, Mr. Seley, who is now retiring from office and who has so modestly passed off the responsibility of office which he has carried so well, and with the one request that you continue your co-operation during the coming season, we will proceed to the next order on the program.

Following the business session the following program of entertainment was enjoyed by the members:

PROGRAM

1. Address.......What the President can do for the Success of the Club
Mr. W. T. McDermott

2. Music ....Illinois Quartette

3. A Scene in a Railway Photograph Gallery......Miss Theo. Cleveland

4. Music ....Illinois Quartette

5. Address..........................Why the President is a Great Man
Mr. D. S. Donahue

Mr. Donohue is connected with the Chicago Daily Journal; besides being a journalist, war correspondent and railroad reporter he has had unusual opportunities to observe the actions of club presidents, and while he talks in an inimitable

PROGRAM—Continued

style, his remarks are liberally interspersed with rapid-fire crayon caricatures and cartoons illustrative of his remarks. Without these illustrations his remarks would be meaningless.

6. A Japanese Song.................................Miss Theo. Cleveland
   Miss Sallie Bryant, Accompanist

7. Music ....Illinois Quartette

8. A Talk................Does it Pay to Advertise During Hard Times
   Mr. E. S. McCune

   Mr. McCune has had varied experiences pro and con (mostly con) on this important subject, and it is amusing to hear a recital of them. Mr. McCune means every word he says and you should hear him say it.

9. While the members are retiring (from the room) the Quartette will favor us.

CONSTITUTION

ARTICLE I.

NAME.

The name of this association shall be the Western Railway Club.

ARTICLE II.

OBJECTS.

The objects of this association shall be the advancement of knowledge relating to safe and economical railway operation, and to the construction, maintenance and service of railway machinery, motive power and rolling stock, by discussion in common, investigation and reports of the experience of its members; to provide an organization through which the members may help to bring about uniformity and interchangeability of the parts of railway cars, to improve their construction, and to adjust the mutual interests growing out of their interchange and repair.

ARTICLE III.

MEMBERSHIP.

This club shall consist of persons interested in railroad matters generally, who may be admitted by a majority of quorum vote of the executive committee and the payment of the annual assessment, and who shall receive copies of the proceedings issued in the current year prior to the date of admission to the club, provided the secretary has sufficient additional copies for this purpose.

ARTICLE IV.

OFFICERS.

The officers of this club shall hold office for one year, to be elected at the annual meeting, and shall consist of:

1. A president, who shall preside at all meetings of the club and perform the duties pertaining to a presiding officer. He shall also be a member and chairman of the executive committee, shall approve of all bills before payment, and shall countersign all checks drawn by the treasurer on the funds of the club, said checks not being negotiable without his signature.

2. A vice-president, who shall, in the absence of the president, perform all duties required of that officer.

3. A second vice-president, who shall, in the absence of both the president and vice-president, perform the duties of the office of president.

4. A secretary, who shall also be the secretary of the executive committee and a member of that committee. The secretary shall be appointed by

the executive committee, and shall keep the minutes of all meetings, have charge of the publication of the club proceedings, and perform other routine work pertaining to the business affairs of the club, under the direction of the executive committee.

5. A treasurer, who shall have charge of all funds, and pay all bills when audited by the executive committee and approved by the president, and who shall submit at each regular meeting of the executive committee an exact statement of his accounts and the condition of the funds of the club, and shall make an annual report to the club at the end of the year, and such reports during the year of the condition of the funds of the club as may be required.

6. The executive committee shall consist of six members, including the officers of the club and a sixth member of the committee, who shall be elected by the club. The executive committee shall arrange programmes for meetings and have general supervision over the interests of the club, and shall audit all bills before payment and audit the books of the secretary and treasurer at each regular meeting.

ELECTION.

7. Election shall be had by informal written ballot for nominations, to be followed by a formal written ballot for election. Only the two candidates receiving the highest number of votes in the informal ballot shall be voted upon in the formal ballot.

ARTICLE V.

AMENDMENTS.

This constitution may be amended at any regular meeting of the club by a three-fourths vote of the members present and voting, said amendment having been proposed in writing at a previous regular meeting.

ARTICLE VI.

DISCUSSION BY PATENTEES.

No patentees or their agents, or agents for the sale of railway supplies shall occupy the attention of the meeting in the interests of devices in which they are personally or financially interested, unless they are especially invited to do so by a majority of the members present, or by consent of a majority of the executive committee, and then only when the article they represent forms a part of the subject for discussion at the regular meeting.

ARTICLE I.

SECTION 1. Meetings of the club shall be held on the third Tuesday of each month at 2 P. M., except in the months of June, July and August.

SEC. 2. The annual meeting shall be held on the third Tuesday in May of each year.

SEC. 3. The president, or a majority of the executive committee, may call special meetings at such times as he or they may deem expedient.

ARTICLE II.

At any regular meeting, five members shall constitute a quorum.

ARTICLE III.

The order of business shall be as follows:

1. Approval of minutes.
2. Announcement of new members and reception of applications for membership.
3. Unfinished business.
4. Reports of committees.
5. New business.
6. Discussion of paper read at previous meeting.
7. Recess.
8. Presentation of paper or report.
9. Appointment of committees.
10. Election of officers.
11. Announcement of subject for next meeting.
12. Adjournment.

ARTICLE IV.

Any person eligible under the constitution, and having been elected by the executive committee, becomes a member of the association by paying the annual dues. All members, whether railway employes or railway supply agents, shall have equal rights in all discussions, and in all business which properly comes before the meetings of the club, except as provided in Article VI of the Constitution.

ARTICLE V.

At the annual meeting, the names of those members whose assessments are unpaid for the year then ended, may be dropped from membership, and such persons shall not be eligible to further membership until all back dues are paid.

ARTICLE VI.

The executive committee is expected to provide papers or matter for discussion at each regular meeting; to have the same in print for distribution at the meeting, and to arrange for prompt publication of the proceedings.

ARTICLE VII.

The secretary will mail the printed proceedings to all members of this and other exchanging railroad clubs, and to the technical and other papers, not later than the second Saturday after the Tuesday of the meeting. The technical papers are requested not to make reports of the proceedings of the meeting, or of papers read before the club, except as presented in the printed proceedings.

ARTICLE VIII.

The stenographic report of the meeting will be confined to resolutions, motions, and discussions of papers, and all miscellaneous discussion of the affairs of the club or general business will not be reported by stenographer unless specially so instructed by the presiding officer, or by adopted motion of a member.

ARTICLE IX.

These by-laws may be amended at any regular meeting of the club by a vote of three-fourths of the members present and voting; such amendment having been proposed in writing at a previous regular meeting.

LIST OF MEMBERS

W. F. Ackerman, M. M., C. B. & Q. Ry., Havelock, Neb.
A. C. Adams, Gen. Foreman, C. B. & Q., Ry., Alliance, Neb.
A. W. Adams, Sales Mgr., Allen & Morrison Brake Shoe Co., Woman's Temple, Chicago, Ill.
C. E. Adams, Draftsman, Ill. Cent. R. R., Chicago, Ill.
J. J. Adams, 117 No. Scott Street, Sheridan, Wyoming.
L. M. Addleman, R. H. F., C. & N. W. Ry., Tomahawk, Wis.
R. H. Aishton, Gen. Mgr., C. & N. W. Ry., Chicago, Ill.
T. W. Aishton, Gen. Supt., C. & N. W. Ry., Chicago, Ill.
G. A. Akerlind, National Dump car Co., Chicago, Ill.
C. J. Albert, Mgr. Western Dept., Cleveland Pneumatic Tool Co., 704 Fisher Bldg., Chicago, Ill.
F. L. Alcott, Foreman Test Room, C. M. & St. P. Ry., W. Milwaukee, Wis.
Walter Alexander, A. D. M. M., C. M. & St. P. Ry., W. Milwaukee, Wis.
C. J. Allen, Box 528, Milwaukee, Wis.
L. S. Allen, R. F. E., C. & N. W. Ry., Chicago.
E. H. Allfree, Chief Draftsman, Locomotive Appliance Co., Chicago, Ill.
C. R. Allison, Draftsman, C. H. & D. Ry., Lima, O.
W. L. Allison, M. E., A. T. & S. F. Ry., Chicago, Ill.
R. C. Alsdorf, Draftsman, C. R. I. & P. Ry., Chicago, Ill.
Chris Anderson, G. C. F., C. R. I. & P. Ry., Chicago, Ill.
C. M. Anderson, care C. B. & Q. Ry., Decorah, Ia.
C. F. Ames, Railway Exchange Bldg., Chicago, Ill.
David Anderson, M. M., Chicago, Union Traction Co., Clearing, Ill.
E. C. Anderson, Draftsman, C. B. & Q. Ry., Chicago, Ill.
Geo. T. Anderson, Supt., C. N. Y. & B. Ry., Elston, Ill.
Gus Anderson, care C. M. & St. P. Ry., Perry, Ia.
Olaf Anderson, Draftsman, C. & N. W. Ry., Chicago, Ill.
W. W. Andrews, Gen. Supt., Northern Territories Ry., Port Darwin, Northern Territory of Australia.
F. R. Angell, National Mall. Castings Co., Chicago, Ill.
F. J. Angier, Mgr. W. P. Plants, C. B. & Q. Ry., Galesburg, Ill.
J. B. Arbuthnot, G. S. K., C. & E. I. R. R., Danville, Ill.
E. J. Arlein, Patton Paint Co., Chicago, Ill.
E. N. Armstrong, Gen. Supt., T. P. & W. Ry., Peoria, Ill.
B. J. Arnold, Borland Block, Chicago, Ill.
W. C. Arp., S. M. P., Vandalia R. R., Terre Haute, Ind.
A. J. Ashton, C. C. Supt. Tel., C. & E. I. R. R., Chicago, Ill.
B. S. Atkinson, G. F. & P. A., Louisiana & Arkansas Ry., Texarkana, Ark.
W. W. Atterbury, G. M., Penna. R. R., Philadelphia, Pa.
C. B. Ault, Lawrenceville Bronze Co., Pittsburg, Pa.
F. R. Austin, Auditor, E. & T. H. Ry., Evansville, Ind.
T. G. Averill, Marvin Mfg. Co., Chicago, Ill.
C. A. V. Axen, G. F., C. & N. W. Ry., Kaukanna, Wis.
G. F. Axtell, 6540 Woodlawn Ave., Chicago, Ill.
C. F. W. Axen, Foreman Mach., Ill. Cent. R. R., Kankakee, Wis.
A. R. Ayers, Supt. Shops, L. S. & M. S. Ry., Collinwood, O.
C. M. Bailey, R. F. E., C. B. & Q. Ry., McCook, Neb.
Geo. H. Baird, Asst. to Gen. Mgr., Pullman Co., Chicago, Ill.
Wm. Baird, G. C. I., C. B. & Q. Ry., Lincoln, Neb.
C. M. Baker, Murphy Varnish Co., Chicago, Ill.
F. L. Baker, 15332 Vine Ave., Harvey, Ill.
H. Baker, G. S., St. L. I. M. & S. Ry., Little Rock, Ark.
J. A. Baker, 1826 Henderson St., Columbia, S. C.
C. F. Balch, 1757 Columbia Road, Washington, D. C.
J. W. Balderston, M. M., Colo. & Wyo. Ry., Sunrise, Wyo.
J. A. Baldwin, Berlin Machine Works, Chicago, Ill.
W. H. Baldwin, Adams & Westlake Co., Chicago, Ill.
W. M. Baldwin, Galena Signal Oil Co., Chicago, Ill.
A. L. Ball, R. H. F., I. I. & I. Ry., Kankakee, Ill.
H. F. Ball, American Loco. Auto Co., New York City.
W. J. Ball, 408 Couch Bldg., Portland, Oregon.
O. J. Bamford, Standard Steel Works, Chicago, Ill.
John Bane, Loco. Engr., C. & W. I. Ry., Chicago, Ill.
E. D. Bangs, Bangs Oil Cup Co., Milwaukee, Wis.
D. C. Barbee, Prest., Standard Metal Mfg. Co., Chicago, Ill.

J. C. Barber,
L. W. Barber, Standard Car Truck Co., Chicago, Ill.
J. C. Barber, Standard Car Truck Co., Chicago, Ill.
Harry Barnhard, Draftsman, Armour Car Lines, Chicago, Ill.
C. A. Barnes, Foreman, Belt R. R., Chicago, Ill.
A. H. Barnhart, For., C. & N. W. Ry., Logan, Ia.
M. K. Barnum, C. B. & Q. Ry., Chicago, Ill.
J. M. Barr. Seaboard Air Line Ry., Portsmouth, Va.
J. H. Barrowdale, G. F. C. D., Ill. Cent. R. R.. Chicago, Ill.
J. J. Berry, Gen. Foreman, Norfolk & Western Ry., Roanoke, Va.
L. L. Barth, V. P.. Edw. Hines Lumber Co., Chicago, Ill.
W. S. Bartholomew, Western Mgr., Westinghouse Air Brake Co., Chicago, Ill.
Hugh Bartlett, 40 Pine Grove Ave., Chicago, Ill.
T. F. Barton, M. M., Illinois Central R. R., Chicago. Ill.
F. Bakerfield, Mgr. West. Ry. Dept., Crucible Steel Co., Chicago, Ill.
G. M. Basford. American Loco. Co., 30 Church St., New York City.
E. M. Bassler, Ry. Dept., Green Fuel Economizer Co., Chicago, Ill.
Geo. D. Bassett, Crerar, Adams & Co., Austin, Ill.
F. C. Batchelder, Supt. B. & O. R. R., Baltimore, Md.
P. H. Batten, 52 Walton Place, Chicago, Ill.
W. M. Baxter, Special Appr., Illinois Central R. R., Chicago, Ill.
S. L. Bean. M. S., A. T. & S. F. Ry., Los Angeles, Cal.
A. L. Beardsley, Mgr.. Cleveland Twist Drill Co., Chicago, Ill.
W. H. Beattys, National Electric Co., Chicago, Ill.
G. W. Beebe, Wheel Inspr., C. B. & Q. Ry., Aurora, Ill.
W. E. Beecham, Car Acct., C. M. & St. P. Ry., Chicago, Ill.
Geo. Beland, Fitz-Hugh-Luther Co., Chicago, Ill.
R. E. Belknap, Agent, Pennsylvania Steel Co., Chicago, Ill.
J. M. Bell, Spec. Appr., C. B. & Q. Ry., W. Burlington, Ia.
T. S. Bell, 31 Nassau St., New York City.
R. W. Bell, M. M., Illinois Central R. R., Waterloo, Ia.
A. Bement, American Trust Bldg., Chicago, Ill.
B. W. Benedict, A. T. & S. F. Ry., Topeka, Kas.
J. H. Benedixen, V. P., Bettendorf Axle Co., Davenport, Ia.
Henry Beneke, Ry. Dept., Hibbard, Spencer, Bartlett & Co., Chicago, Ill.
C. H. Benjamin, Dean. Engineering Schools, Purdue University, Lafayette, Ind.
F. G. Benjamin, M. M., C. & N. W. Ry., Clinton, Ia.
H. T. Bentley, A. S. M. P., C. & N. W. Ry.. Chicago, Ill.
W. F. Bentley. G. C. I., B. & O. R. R., Baltimore, Md.
G. I. Bergen, Pur. Agt., Chicago City Ry Co., Chicago, Ill.
E. F. Berger, Midvale Steel Co., Chicago, Ill.
J. L. Berman, Northwestern Elevated Ry., Chicago, Ill.
W. P. Bettendorf, Bettendorf Axle Co., Davenport, Ia.
A. M. Bickel, Traveling Engr., L. S. & M. S. Ry., Elkhart, Ind.
H. T. Bigelow, Gen. Sales Agt., Hale & Kilburn Co., Chicago, Ill.
Owen Bigelow, Gen. Foreman, C. & E. I. R. R., Momence, Ill.
Jos. Billingham, Vacuum Oil Co., London, England.
G. C. Bingham, Mach. Foreman, C. & N. W. Ry., Winona, Minn.
Geo. Bird, Supt., Fitz-Hugh-Luther Co.
G. A. Bischoff, Nathan Mfg. Co., Chicago, Ill.
Prof. G. W. Bissell, Michigan Agriculture College, Lansing, Mich.
Robt. Bissett, Sr., G. F., C. B. & Q. Ry., Creston. Ia.
W. A. Blanchard. American Steel Foundries, Chicago, Ill.
Carter Blatchford, Spencer Otis Co., Chicago, Ill.
W. L. Bleecker, Prest., Universal Mfg. Co., Boulder, Colo.
W. L. Bliss. Prest., Bliss Elec. Car Lighting Co.. Milwaukee, Wis.
Francis Blossom, Sanderson & Porter, Engineers, New York City.
Chas. Bloxham, M. C. B., Union Tank Line, New York City.
O. W. Bodler, 305 Dearborn St., Chicago, Ill.
F. J. Boedefeld, Foreman, Carpenter Shops, L. S. & M. S. Ry., Elkhart, Ind.
J. E. Bond, M. E., American Locomotive Equipment Co., Maywood, Ill.
C. E. Bonnell, V. P., Nubian Paint & Varnish Co., Chicago, Ill.
E. M. Bostwick. C. C. to M. M., Belt Ry., Chicago, Ill.
A. G. Bott. Bedford, Ind.
Wm. Boughton, R. F. of E., Pere Marquette Ry., Saginaw, Mich.
W. G. Boulton, Agent, Union Tank Line Co., Chicago, Ill.
Geo. L. Bourne, 1515 Old Colony Bldg., Chicago, Ill.
J. G. Bower, Pressed Steel Car Co., Chicago, Ill.
H. A. Bowen, 626 Swan St., Terre Haute, Ind.
K. J. Bowers, Sales Mgr., Acme White Lead & Color Wks., Detroit, Mich.
W. F. Bowers, Illinois Central R. R., Chicago, Ill.
S. J. Bowling, 1327 Majestic Bldg., Detroit, Mich.
A. W. Bowman. Gen. Yard Master, C. & E. I. R. R., Chicago. Ill.
Geo. N. Boyd, The Pantasote Co., Chicago, Ill.
S. M. Braden, C. & N. W. Ry., Norfolk, Neb.
W. H. Bradley, A. M. M., C. & N. W. Ry. Boone, Ia.
D. M. Brady, Prest., Brady Brass Co., Jersey City, N. J.
T. F. Brady. M. M., Mapimi Ry., Mapimi, Durango, Mexico.
J. H. Bradshaw, American Cotton Oil Co., Chicago, Ill.

G. R. Brandon, Gen. Engr., Whiting Fdy. Equipment Co., Harvey, Ill.
J. B. Brady, 170 Broadway, New York City.
F. O. Brazier, Murphy Varnish Co., Chicago, Ill.
F. W. Brazier, A. S. R. S., N. Y. C. & H. R. R. R., New York City.
Prof. L. P. Breckenridge, University of Illinois, Urbana, Ill.
J. F. Breitenstein, Machinist, C. B. & Q. Ry., Burlington, Ia.
H. N. Breneman, A. S. M. P., C. M. & St. P. Ry., Milwaukee, Wis.
Geo. H. Bremner, Engr. M. of W., Ill. Dist., C. B. & Q. Ry., Chicago, Ill.
W. O. Brewster, Draftsman, C. B. & Q. Ry., Chicago, Ill.
C. S. Bricker, Lancaster, Pa.
C. G. Brittingham, T. M., St. L. K. C. & Colo. Ry., Eldon, Mo.
J. G. Broman, Superior Chemical Comp. Works, Chicago, Ill.
J. L. Bronson, Engineer C. & W. I. Ry., Chicago, Ill.
Geo. D. Brooke, S. M. P., Isthmian Canal Commission, Culebra, Canal Zone.
A. V. Brown, Div. Supt., C. B. & Q. Ry., Ottumwa, Ia.
B. E. Brown, J. B. Sipe & Co., Detroit, Mich.
C. R. Brown, Manning, Maxwell & Moore, Chicago, Ill.
F. R. Brown, Div. Storekeeper, C. B. & Q. Ry., St. Joseph, Mo.
Geo. V. Brown, Train Desp., Belt Ry., Chicago, Ill.
I. H. Brown, 1101 Traction Bldg., Cincinnati, O.
J. T. Brown, Damascus Bronze Co., Pittsburgh, Pa.
R. L. Brown, Fisher Bldg., Chicago, Ill.
S. D. Brown, C. C. to G. S. M. P., C. B. & Q. Ry., Chicago, Ill.
S. H. Brown, Asst. Supt., C. & N. W. Ry., Sioux City, Ia.
H. S. Bryan, M. M., Duluth & Iron Range R. R., Two Harbors, Minn.
G. H. Bryant, Thos. Prosser & Son, Chicago, Ill.
Eugene Bruckman, Berlin Engine Works, Berlin, Germany.
W. F. Buck, S. M. P., A. T. & S. F. Ry., Chicago, Ill.
E. J. Buckbee, Mach. Foreman, C. C. C. & St. L. Ry., Urbana, Ill.
C. L. Buckingham, Draftsman, C. R. I. & P. Ry., Chicago, Ill.
B. I. Budd, G. M., Metropolitan Elevated Ry., Chicago, Ill.
D. C. Buell, 233 Railway Exchange Bldg., Chicago, Ill.
H. C. Buhoup, Great Northern Bldg., Chicago, Ill.
J. E. Buker, A. S. M., Illinois Central R. R., Chicago, Ill.
Jas. Buker, Gen. Supt., Ostermann, Mfg. Co., W. Pullman, Ill.
C. L. Bundy, Kingsland, N. J.
F. O. Bunnell, E. of T., C. R. I. & P. Ry., Chicago, Ill.
Frank Burke, Traveling Engineer, D. M. & N. Ry., Proctor, Minn.
H. S. Burkhardt, National Mall. Castings Co., Chicago, Ill.
R. W. Burnett, A. M. C. B., Can. Pacific Ry., Montreal, Canada.
J. Burns, Machinist, C. B. & Q. Ry., Creston, Ia.
E. J. Burton,
D. L. Bush, Gen. Supt., C. M. & St. P. Ry., Chicago, Ill.
S. P. Bush, Gen. Mgr., Buckeye Steel Castings Co., Columbus, O.
A. B. Burtis, G. M., Mamalitte Carbon Paint Co., Cincinnati, O.
F. W. Busse, G. S. M. P., B. & O. R. R., Baltimore, Md.
L. E. Butler, 429 N. 113th Street, Philadelphia, Pa.
P. C. Cady, L. S. & M. S. Ry., Cleveland, O.
T. W. Cain, McCord & Co., Chicago, Ill.
H. R. Calehan, Engr., C. M. & St. P. Ry., Savanna, Ill.
J. D. Calehan, R. H. F., C. M. & St. P. Ry., Dubuque, Ia.
J. P. Callahan, M. C. B., C. L. S. & E. Ry., Chicago, Ill.
J. W. Callahan, Train Master, Belt Ry., Chicago, Ill.
T. E. Calvert, C. E., C. B. & Q. Ry., Chicago Ill.
F. C. Cameron, Draftsman, National Dump Car Co., Chicago, Ill.
A. Campbell, Standard Steel Car Co., Chicago, Ill.
J. C. Campbell, Chicago Pneumatic Tool Co., Chicago, Ill.
R. B. Campbell, Gen. Mgr., E. J. & E. Ry., Joliet, Ill.
W. D. Cantillon, G. M., C. & N. W. Ry., Chicago, Ill.
W. L. Campbell, Gen. Yard Master, E. J. & E. Ry., Joliet, Ill.
C. W. Card, Train Master, C. B. & Q. Ry., Aurora, Ill.
J. R. Cardwell, Cardwell Mfg. Co., Chicago, Ill.
B. B. Cargo, M. M., Lake Terminal Ry., Lorain, O.
L. M. Carlton, C. & N. W. Ry., Chicago, Ill.
C. H. Carman, Air Brake Foreman, C. & E. I. R. R., Danville, Ill.
J. A. Carney, Supt. Shops, C. B. & Q. Ry., W. Burlington, Ia.
D. D. Carothers, Gen. Supt., B. & O. R. R. Baltimore, Md.
H. C. Carpenter, N. Z. Graves & Co., Chicago, Ill.
Geo. R. Carr, A. G. M., Dearborn Drug & Chemical Co., Chicago, Ill.
R. E. Carr, V. P., Dearborn Drug & Chemical Co., Chicago, Ill.
W. S. Carr, Secretary, McMaster-Davis Supply Co., Chicago, Ill.
J. T. Carroll, A. M. M., L. S. & M. S. Ry., Elkhart, Ind.
W. F. Carroll, R. F. E., C. & N. W. Ry., Waseca, Minn.
C. A. Carscadin, Monarch Steel Casting Co., Detroit, Mich.
E. C. Carter, C. E., C. & N. W. Ry., Chicago, Ill.
Wm. Case, National Malleable Castings Co., Chicago, Ill.
J. T. Casey, American Car & Fdy. Co., Jeffersonville, Ind.
C. P. Cass, Agent, American Brake Co., St. Louis, Mo.
A. M. Castle, A. M. Castle & Co., Chicago, Ill.
W. B. Causey, Engr. M. of W., C. & A. Ry., Bloomington, Ill.

A. Cauvius, Engr., C. M. & St. P. Ry., Chicago, Ill.
T. T. Cavanaugh, Sculley Iron & Steel Co, Chicago, Ill.
A. B. Chadwick, Armour Car Shops, Chicago, Ill.
Walter Chadwick, Davenport, Locomotive Works, Davenport, Ia.
J. S. Chambers, S. M. P., Atlantic Coast Line Ry., Rocky Mount., N. C.
A. J. Chapman, C. C. Car Acct.; Chicago Indiana & Southern Ry., Hammond, Ind.
J. W. Chase, R. H. F., C. B. & Q. Ry., McCook, Neb.
Jos. Chidley, A. M. M., L. S. & M. S. Ry., Elkhart, Ind.
Geo. S. Chiles, Spec. Appr., L. S. & M. S. Ry.. Collinwood, O.
J. F. Chisholm, Ward Packer Supply Co., Chicago, Ill.
Anton Christenson, Rcpr., Aurora Metal Co., Aurora, Ill.
W. K. Christie, Cimarron, N. Mex.
W. P. Chrysler, S. M. P., Chicago Great Western Ry., Oelwein, Ia.
A. Chubb, F. C. R., C. B. & Q. Ry., La Crosse. Wis.
A. M. Clark, Columbia Engine Works, Portland, Oregon.
D. G. Clark, Firth-Sterling Steel Co., Chicago, Ill.
F. H. Clark, G. S. M. P., C. B. & Q. Ry., Chicago, Ill.
H. H. Clark, Link Belt Machinery Co., Chicago, Ill.
R. B. Clark, Tr., Scullin-Gallagher Iron & Steel Co., Chicago, Ill.
A. W. Clement, Sales Agent, Ohio Brass Co., Mansfield, O.
C. W. Clements, Special Apprentice, B. & O. R. R., Garrett, Ind.
C. S. Clingman, Mechanical Inspector, Pullman Co., Chicago, Ill.
J. W. Cloud, York Road, Kings Cross, London, England.
F. W. Coale, Coale Muffler & Safety Valve Co., Baltimore, Md.
H. H. Coates, 221 8oth Place, Chicago, Ill.
F. R. Coates, 318 G. C. Depot, Chicago, Ill.
F. T. Coe, F. E. H., L. S. & M. S. Ry., Chicago, Ill.
Ernst Cockfield, Draftsman, C. B. & Q. Ry., Aurora, Ill.
G. B. Coffin, Heath & Milligan Co., Chicago. Ill.
F. J. Cole, American Locomotive Co., New York, N. Y.
H. L. Cole, Sales Mgr., Bradford Draft Gear Mfg. Co., Chicago, Ill.
Chas. Coleman, G. F., C. & N. W. Ry., Boone, Ia.
J. H. Coleman, S. C. D., Grand Trunk Ry., Montreal, Canada.
F. P. Collin, J. L. Yale Co., Chicago, Ill.
Chas. Coller, M. C. B., C. I. & I. L. Ry., Lafayette, Ind.
F. G. Colwell, Shop Foreman, Illinois Central R. R., Chicago, Ill.
C. B. Conger, 629 Railway Exchange Bldg., Chicago, Ill.
W. N. Connor Gen. Inspector, C. & E. I. R. R.. Chicago, Ill.
J. T. Conolly, S. M. P.. Duluth, South Shore & Atlantic Ry., Marquette, Mich.
E. H. Cook, Draftsman, A. T. & S. F. Ry., Ft. Madison, Ia.
W. J. Cook, McGuire-Cummings Mfg. Co., Chicago, Ill.
Allen Cooke, Danville, Ill.
G. T. Cooke, Mech. Inspr., Pullman Co., Chicago, Ill.
F. J. Cooledge, J. L. Yale Co., Chicago, Ill.
R. P. Cooley, Mech. Inspector, Pullman Co., Chicago, Ill.
E. S. Cooper, Draftsman, Simplex Railway Appliance Co., Hammond, Ind.
Geo. Cooper, Frost Railway Supply Co., Detroit, Mich.
C. S. Corning, 1213 Fisher Bldg., Chicago, Ill.
H. E. Correll, Asst. Supt., Chicago Lake Shore & Eastern Ry., Chicago, Ill.
C. H. Cory, Lima, O.
J. F. Cosgrove, International Correspondence Schools, Scranton, Pa.
H. H. Cosley, Asst. Sales Agt., Cambria Steel Co., Chicago, Ill.
E. L. Coster, 25 Broad Street, New York City.
A. J. Cota, M. M., C. B. & Q. Ry., Chicago, Ill.
W. H. Cotton, Plymouth Building, Chicago, Ill.
W. J. Courtney, 15 Wall St., New York City.
F. W. Cox, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
T. B. Cram, Railway Materials Co., Chicago, Ill.
H. A. Craig, Supt., Burma Railways Co., Insein. Burma, India.
B. V. Crandall, Editor, "Railway Master Mechanic," Chicago, Ill.
D. F. Crawford, G. S. M. P., Penna. Lines, Pittsburgh, Pa.
J. G. Crawford, Special Appr., C. B. & Q. Ry., Chicago, Ill.
Roy Cresse. C. C. Store Dept., C. R. I. & P. Ry.. Chicago, Ill.
Lincoln Crocker,
O. C. Cromwell, M. E., B. & O. R. R., Baltimore, Md.
W. Cross, Asst. to 2nd V. P. Can. Pac. Ry., Winnipeg, Man.
W. L. Crossman, Repr., Beckwith-Chandler Co., Buffalo, N. Y.
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Warren Edwards, "Iron World," Chicago, Ill.
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J. H. Houck, Supt., Hamler Boiler & Tank Co., Chicago, Ill.
C. H. Howard, Harrison & Howard Iron Co., St. Louis, Mo.
C. E. Howard, Loco. Engr., C. B. & Q. Ry., Chariton, Iowa.
G. E. Howard, V. P., Commonwealth Steel Co., St. Louis, Mo.
H. B. Howe, New South Wales Gov't Rys., Sydney, N. S. W.
C. B. Hoyt, Supt. Construction, N. Y. C. & St. L. Ry., Bellevue, Ohio.
W. E. Hubbard, New York Central & Hudson River Ry., New York City.
I. C. Hubbell, Locomotive Appliance Co., Chicago, Ill.
G. O. Huckett, Roard Foreman, C. B. & Q. Ry., Wymore, Neb.
E. B. Hughes, Inspector, Wabash Ry., Paterson, N. J.
E. E. Hull, Asst. F. C. D., C. B. & Q. Ry., Aurora, Ill.
G. A. Hull, Mech. Eng. Dept., C. R. I. & P. Ry., Chicago, Ill.
A. L. Humphrey, G. M., Westinghouse Air Brake Co., Pittsburgh, Pa.
C. J. Humphreys, Spencer Otis Co., Chicago, Tl.
L. S. Hungerford, Jr., Peerless Rubber Co., Chicago, Ill.
W. R. Hungerford, Mech. Inspr., Pullman Co., Chicago, Ill.
R. L. Huntley, P. A. E., Union Pacific Ry., Omaha, Neb.
T. B. Hunt, Pennsylvania R. R., Ft. Wayne, Ind.
Percival Hunter, Purchasing Dept., C. B. & Q. Ry., Chicago, Ill.
C. F. Huntoon, Chicago Railway Equipment Co., Chicago, Ill.
J. D. Hurley, V. P., Independent Pneumatic Tool Co., Chicago, Ill.
C. I. Hutton, Div. Supt., Burma Rys. Co. Ltd., Insein, Burma, India.
G. C. Isbester, Railway Appliance Co., Chicago, Ill.
G. R. Ingersoll, C. C. Pur. Agt., L. S. & M. S. Ry, Cleveland, O.
E S. Jackman, Western Agent, Forth Sterling Steel Co., Chicago, Ill.
C. F. Jacobson, Foreman, Machine Shops, L. S. & M. S. Ry., Ekhart, Ind.
E. J. Jackson, Machinist, C. B. & Q. Ry., Chicago, Ill.
J. A. Jackson, G. F., Chicago Refr. Car Co., Chicago, Ill.
O. S. Jackson, R. H. F., C. I. & L. Ry., Indianapolis, Ind.
W. J Jackson, Loco. Engr., C. & W. I. Ry., Chicago, Ill.
W. L. Jacoby, Union League Club, Chicago, Ill.
W. O. Jacquette, Dist. Mgr., Pressed Steel Car Co., New York City.
Geo. James, D. M. M., N. Y. C. & St. L. Ry., Stoney Island, Ill.
E. D. Jameson, A. M. M., Grand Trunk Ry., Battle Creek, Mich.
Wm. Jappert, Car Foreman, C. B. & Q. Ry., Lincoln, Neb.
J. J. Jaschka, National Malleable Castings Co., Chicago, Ill.
E. Z. Jefferson, Quaker City Rubber Co., Pittsburgh, Pa.
B. H. Jeffries, Loco. Engr., Wabash Ry., Chicago, Ill.
C. D. Jenks, Sales Agt., Pressed Steel Car Co., Chicago, Ill.
D. F. Jennings, Stewart Mowry Co., Chicago, Ill.
E. E. Jett, Supt. Car Shops, Morris & Co., Chicago, Ill.
Jacob Johann, Springfield, Ill.
M. E. Johns, 117 Green St., Jersey City, N. J.
August Johnson, Engr., Elgin, Joliet & Eastern Ry., Joliet, Ill.
A. E. Johnson, Storekeeper, C. & N. W. Ry., Kaukauna, Wis.
A. B. Johnson, Salesman, Westinghouse Machine Co., St. Louis, Mo.
C. H. Johnson, G. F. L. D., Michigan Central R. R., Chicago, Ill.
E. G. Johnson, Brunswick Hotel, Moncton, N. B.
F. J. Johnson, American Hoist & Derrick Co., Chicago, Ill.
H. A. Johnson, Engr. Car Equip., Metropolitan Elevated R. R., Chicago, Ill.
H. W. Johnson, D. M. M., C. B. & Q. Ry., Brookfield, Mo.
R. H. Johnson, G. M., Peoria & Pekin Union Ry., Peoria, Ill.
W. O. Johnson, M. M., Empire Shops, Canal Zone.
H. C. Johnstone, F. A. Lester & Co., Chicago, Ill.
B. D. Jones, Jones Car Door Co., Chicago.
R. E. Jones, Engr., C. B. & Q. Ry., Burlington, Ia.
B. M. Jones, B. M. Jones & Co., Boston, Mass.
E. H. Jones, Secretary, Northwestern Expanded Metal Co., Chicago, Ill.
E. F. Jones, G. F., Chicago & Western Indiana Ry., Chicago, Ill.
F. B. Jones, Adams & Westlake Co., Chicago, Ill.
L. E. Jones, American Steel Foundries, Chicago, Ill.

M. T. Jones, Insp. Engr., American Bureau of Inspection & Tests, Chicago.
W. A. Jones, Pennsylvania Lines West, Ft. Wayne, Ind.
W. E. Jones, G. F., German-American Car Lines, Chicago, Ill.
G. R. Joughins, M. S., Intercolonial Ry., Moncton, N. B., Canada.
W. H. Judson, M. E, Street's Western Stable Car Line, Chicago, Ill.
B. Julien, G. F. C. D., Union Pacific R. R., Omaha, Nebr.
R. B. Kadish, 99 Hill Street, Chicago, Ill.
I. N. Kalbaugh, S. M. P., Coal & Coke Ry., Gassaway, W. V.
F. W. Kapnick, Engr., Chicago & Western Indiana Ry., Chicago, Ill.
H. G. Kastlin. G. F., C. B. & Q. Ry., Savannah, Ill.,
Jacob Kastlin, Supt., Davenport Loco. Works, Davenport, Ia.
J. E. Keegan, S. M. P., Grand Rapids & Indiana Ry., Grand Rapids, Mich.
B. A. Keeler, Chicago Car Heating Co., Chicago, Ill.
Sanford Keeler, Nathan Mfg. Co., Chicago, Ill.
C. E. Keenan, G. L. I., New York Central & Hudson River R. R., W. Albany, N. Y.
C. L. Keller, 1st Asst. Engr., Scherzer Lift & Bridge Co., Chicago, Ill.
H. D. Kelley, Demonstrator, C. & N. W. Ry., Chicago, Ill.
J. W. Kelly, Foreman Boiler Maker, C. & N. W. Ry., Oak Park, Ill.
M. J. Kelley. G. F., Pere Marquette R. R., Chicago, Ill.
W. A. Kelley, R. F E, C. B. & Q. Ry., Burlington, Ia.
Wm. V. Kelley, Simplex Railway Appliance Co., Chicago. Ill.
W. L. Kellogg. G. M. M., Pere Marquette Ry., Grand Rapids, Mich.
A. A. Kellogg. Chief Draftsman, Toledo, St. Louis & Western Ry., Frankfort, Ind.
Willard Kells, M. M., Lehigh Valley Ry., Buffalo N. Y.
O. O. Kendall, Engineer. Chicago & Western Indiana Ry., Chicago. Ill.
R. B. Kendig, M. E., L. S. & M. S. Ry., Cleveland, O.
Chas. Kennedy, Brown & Co., Inc., Chicago, Ill.
C. L. Kennicott, Kennicott Water Softener Co., Chicago, Ill.
S. K. Kenower, Dixon, Ill.
E. R. Kent, E. R. Kent & Co., Chicago, Ill.
H. P. Kepner, Piece Work Inspr., C. B. & Q. Ry., Havelock, Nebr.
J. A. Kershaw, Supt. Air Brakes. C. M. & St. P. Ry., W. Milwaukee, Wis.
E M Kerwin, Sprague Electric Co., Chicago, Ill.
H. J. Kessler, Draftsman, C. B. & Q. Ry., Lincoln, Nebr.
H. B. Ketzle, National Dump Car Co., Chicago, Ill.
S. J. Kidder, Westinghouse Air Brake Co., 165 Broadway, New York City.
Chas. Kilander, American Steam Gage & Valve Mfg. Co., Chicago, Ill.
J. B. Kilpatrick, Asst. S. M. P., C. R. I. & P. Ry., Chicago, Ill.
N. S. Kimball, M. M., C. M. & St. P. Ry., Green Bay, Wis.
C. H. King, Machinist, L. S. & M. S. Ry., Chicago, Ill.
C. King, G. F. C. D., C. M. & St. P. Ry., Minneapolis, Minn.
F. I. King, 137 E. Front St., Dunkirk, N. Y.
C. W. Kinney, 410 St. Clair Ave., Columbus, O.
A. R. Kipp, The Arnold Co., Chicago, Ill.
T. B. Kirby, Railway Exchange Bldg., Chicago, Ill.
J. Kirk, Supt., Chicago, Lake Shore & Eastern Ry., Chicago, Ill.
John Kirkby, Mechanical Engineer, Pilsley, Chesterfield, England.
M. M. Kirkman, V. P. Chicago & Northwestern Ry., Chicago, Ill.
W. B. Klee, Damascus Bronze Co., Pittsburgh. Pa.
Chas. Kleeman, C. R. I. & P. Ry., Chicago. Ill.
Geo. Kleifgen, New York Air Brake Co., Chicago. Ill.
D. Z. Kline, F. C. R., Grand Rapids & Indiana Ry., Grand Rapids, Mich.
C. F. Kopf, Griffin Wheel Co., Chicago, Ill.
F. T. Kraemer, R. F. E., C. B. & Q. Ry., Little Rock, Ark.
T. N. Kucher, M. M., Toledo, Peoria & Western Ry., Peoria, Ill.
Chas. Krau, Asst. R. H. F., L. S. & M. S. Ry, Elkhart, Ind.
E. E. Kretchmer, Northwestern Elevated R. R., Chicago, Ill.
P. M. LaBach, Draftsman, C. R. I. & P. Ry., Chicago, Ill.
Wm. Lalor, Foreman, C. B. & Q. Ry., Galesburg, Ill.
M. B. Lambert, Engr., Westinghouse Elec. & Mfg. Co., Chicago, Ill.
R. P. Lamont, V. P., Simplex Railway Appliance Co., Hammond, Ind.
J. S. Lanby, Apprentice Instr., L. S., & M. S. Ry., Elkhart, Ind.
J. R. Lancaster, Inspr. Materials, L. S. & M. S. Ry., Cleveland, O.
E. H. Landers, Storekeeper, L. S. & M. S. Ry, Chicago, Ill.
J. N. Langan, Chicago Indiana & Southern Ry., Kankakee, Ill.
C. F. Lape, 216 Stimson Block, Los Angeles, Cal.
M. LaQuay, 1329 E. 9th Street, Kansas City, Mo.
H. LaRue, M. C. B., C. R. I. & P. Ry., Chicago, Ill.
H. P. Latta, S. M. P., Mobile, Jackson & Kansas City Ry., Mobile, Ala.
G. F. Laughlin, Supt. Shops, Armour Car Lines Kansas City, Kansas.
W. K. Lavis, Piece Work Inspr., C. B. & Q. Ry., Aurora, Ill.
T. A. Lawes, M. E., New York, Chicago, & St. Louis Ry., Cleveland, O.
F. A. Lawler, Crucible Steel Co., Chicago, Ill.
W. M. Lawler, Asst., G. S. M., Bliss Electric Car Lighting Co., Chicago, Ill.
W. C. Lawson, Lawson & Simons, Chicago, Ill.
Park, Pa.
J. F. Laying, 333 Locust St., Edgewood
L. H. Ledger, Loco. Engr., A. T. & S. F. Ry., Los Angeles, Cal.

E. H. Lee, Chief Engr., Chicago & Western Indiana Ry., Chicago, Ill.
Frank Lee, Asst. Engr., Canadian Pacific Ry., Winnipeg, Man.
W. C. Lee, Storekeeper, Illinois Steel Co., Chicago, Ill.
E. B. Leigh, V. P., Chicago Ry. Equipment Co., Chicago, Ill.
E. F. Leigh, Chicago Railway Equipment Co., Chicago, Ill.
F. B. Leopold, 718 Maple Ave., Sewickley, Pa.
C. F. Leppla, Draftsman, C. R. I. & P. Ry., Chicago, Ill.
F. A. Lester, 374 Fifth Ave., New York City.
J. C. Lester, Spokane, Wash.
H. R. Lewellyn, Chicago Mall. Castings Co., W. Pullman, Ill.
B. F. Lewis, Railway Appliance Co., Chicago, Ill.
E. Lewis, G. M., Solid Draft Rigging & Equipment Co., Terre Haute, Ind.
E. Lewis, Westinghouse Machine Co., Chicago, Ill.
F. S. Lewis, Illinois Steel Co., Chicago, Ill.
J. H. Lewis, F. R. H., C. B. & Q. Ry., Chicago, Ill.
W. H. Lewis, S. M. P., Norfolk & Western Ry., Roanoke, Va.
E. A. Lewman, Montezuma, Park Co., Mo.
J. H. Leyonmark, M. E., Chicago & Alton Ry., Bloomington, Ill.
W. A. Libkeman, Standard Steel Car Co., Chicago, Ill.
H. T. Person, Library, Tuck School, Hanover, N. H.
T. G. Lickey, Asst. Foreman, L. S. & M. S. Ry., Chicago, Ill
R. M. Lickley, C. D., New York. New Haven & Hartford R. R., New Haven, Conn.
G. H. Likert, M. M., Union Pacific Ry., Omaha, Neb.
M. T. Lightner, Mechanical Dept., Chicago & Alton Ry., Bloomington, Ill.
C. A. Lindstrom, C. E., Pressed Steel Car Co., Allegheny, Pa.
H. R. Linn, Postel & Linn, Chicago, Ill.
J. A. Lister, Inspr., Pittsburg Testing Laboratory, Evanston, Ill.
J. C. Little, M. E., C. & N. W. Ry., Chicago, Ill.
J. T. Llewellyn. Chicago Malleable Castings Co., Pullman, Ill.
B. D. Lockwood, M. E., C. C. C. & St. L. Ry., Indianapolis, Ind.
P. T. Lonergan, M. M., Boston & Albany Ry., Springfield, Mass.
J. H. Lonie, A. M. E., American Steel Foundries, Granite City, Ill.
H. L. Loomis, 827 Rookery Bldg. Chicago, Ill.
Alfred Lovell, 819 Harrison Bldg., Philadelphia, Pa.
C. P. Lovell, New York Air Brake Co., Chicago, Ill.
R. S. Lowder, Draftsman, C. & N. W. Ry., Chicago, Ill.
Houston Lowe, Lowe Bros. Co., Dayton, O.
W. W. Lowell, D. M. M., C. B. & Q. Ry., St. Joseph, Mo.
J. A. Lounsbury, V. P., Greenlee Bros. Co., Chicago, Ill.
J. A. Loy, M. M., C. R. I. & P. Ry., Rock Island, Ill.
F. M. Lucore, 407 Grand Central Station, Chicago, Ill.
Wm. Lucy, Loco. Engr., Chicago & Western Indiana Ry., Chicago, Ill.
C. G. Ludlow, Crosby Steam Gage & Valve Co., Chicago, Ill.
C. J. Lunquist, Foreman, Coach Repairs, C. M. & St. P. Ry., Minneapolis, Minn.
Tracy Lyon, Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.
Jas. Lyman, Engineer, General Electric Co., Chicago Ill.
J. W. Mabbs, C. E., Board of Trade, Chicago, Ill.
D. R. MacBain, A. S. M. P., Michigan Central Ry., Detroit, Mich.
Wm. McFarlane, Chicago Junction Ry., Chicago, Ill.
D. R. MacKenzie, Loco. Foreman, Chicago Great Western Ry., Chicago, Ill.
Jno. Mackenzie, 60 Hawthorne Ave., Cleveland, O.
J. F. Mackie, Secretary, Train Despatchers Ass'n of America, Chicago, Ill.
W. H. Maddocks, Missouri, Kansas & Texas Ry., Parsons, Kas.
A. F. Macpherson, 1590 Old Colony Bldg., Chicago, Ill.
W. E. Magraw, V. P., The Railway List Co., Chicago, Ill.
J. T. Maher, American Steel Foundries, Chicago, Ill.
Peter Maher, S. M. P., C. & A. Ry., Bloomington, Ill.
J. H. Mallon, T. M., South Side Elevated R. R., Chicago, Ill.
Geo. B. Maltby, 516 American Trust Bldg., Chicago, Ill.
A. E. Manchester, S. M. P., C. M. & St. P. Ry., W. Milwaukee, Wis.
P. Manchester, Quincy, Manchester Sargeut Co., Chicago, Ill.
H. S. Mann, Engineer, Wabash Ry., Chicago, Ill.
J. H. Manning. S. M. P. Delaware & Hudson Co., Albany, N. Y.
M. Marea, M. M., Toledo, St. Louis & Western Ry., Frankfort, Ind.
J. T. Markham, Sellers Mfg. Co., Chicago, Ill.
Herbert Markle, Northern Electrical Mfg. Co., Chicago, Ill.
J. R. Markle, Secretary, J. F. McCanna Co., Chicago, Ill.
F. W. Marquis, University of Illinois, Urbana, Ill.
C. E. Marsh, Road Foreman, C. B. & Q. Ry., Galesburg, Ill.
H. M. Marsh, 2451 56th St., Chicago, Ill.
Wm. Marshall, Secretary. Anglo-American Varnish Co., Newark, N. J.
W. H. Marshall, American Locomotive Co., New York City.
P. A. Martin, National Car Line Co., Chicago, Ill.
R. P. Bigelow, Librarian, Massachusetts Institute of Technology, Boston, Mass.
N. Maus, 1603 Prairie Ave., Chicago, Ill.
H. C. May, M. M., Louisville & Nashville R. R., New Decatur, Ala.
A. R. McAlpine, 1434 Monadnock Block, Chicago, Ill.
Edward McArdle, Columbus Pneumatic Tool Co., Chicago, Ill.
Eugene McAuliffe, General Fuel Agt., Rock Island Lines, Chicago, Ill.
Chas. McCanon, Chicago Junction Ry., Chicago, Ill.

J. J. McCarthy, 735 Old Colony Bldg., Chicago, Ill.
Edw. McCarthy, R. H. F., Ill. Cent. R. R., Chicago, Ill.
J. M. McCarthy, C. C. to G. P. A., Rock Island Lines, Chicago, Ill.
M. J. McCarthy, C. C. C. & St. L. Ry., Beech Grove, Ind.
H. O. McClain, Draftsman, Ill. Cent. R. R., Chicago, Ill.
J. H. McConnell, Pittsburgh, Pa.
A. C. McCord, McCord & Co., Chicago, Ill.
H. E. McCormick, Pennsylvania Steel Co., Chicago, Ill.
Jos. McDonald, Foreman, Pattern Shops, C. M. & St. P. Ry., Milwaukee, Wis.
H. G. McDuffie, Asst. P. A., Nelson, Morris & Co., Chicago, Ill.
J. F. McElroy, Cons. Engr., Consolidated Car Heating Co., Albany, N. Y.
J. G. McGee, 90 West Street, New York City.
C. P. McGinniss, 2807 Polk Street, Minneapolis, Minn.
R. J. McGrail, C. C. to S. M. P., Toledo, St. Louis & Western Ry., Frankfort, Ind.
J. A. McGrew, National Engineering Co., Columbus, O.
J. H. McGoff, M. M., A. T. & S. F. Ry., Ft. Madison, Ia.
R. L. McIntosh, Asst. M. E., Missouri Pacific Ry., St. Louis, Mo.
Wm. McIntosh, S. M. P., Central R. R. of New Jersey, Jersey City, N. J.
W. T. McKee, 71 West Main Street, Mt. Sterling, Ky.
Benj. McKeen, Gen. Mgr., Vandalia R. R., St. Louis, Mo.
W. R. McKeen, Jr., S. M. P., Union Pacific Ry., Omaha, Neb.
A. J. McKillop, M. M., Illinois Central R. R., Freeport, Ill.
S. C. McKnight, 7772 Hawthorne Ave., Chicago, Ill.
J. G. McLaren, 4911 Wabash Ave., Chicago, Ill.
A. H. McLean, 206 High Street, Urbana, Ill.
H. B. McLelland, Jenkins Bros., Chicago, Ill.
Wm. McMasters, P. A., Indiana Harbor R. R., Chicago, Ill.
S. W. McMunn, Kindl Car Truck Co., Chicago, Ill.
W. N. McMunn, Latrobe Steel & Coupler Co., Chicago, Ill.
W. V. McNamara, Car Foreman, Norfolk & Western Ry., Williamson, W. Va.
Jas. McNaughton, American Locomotive Co., Schenectady, N. Y.
M. B. McNulty, Pratt & Lambert Varnish Co., Chicago, Ill.
J. H. McPartland, Inspr. Car Service, C. B. & Q. Ry., Burlington, Iowa.
J. A. McRae, M. E., Michigan Central R. R., Detroit, Mich.
G. E. McVicar, Galena Oil Co., Franklin, Pa.
Robt. McVicar, Galena Signal Oil Co., Franklin, Pa.
C. H. Mead, Empire, Canal Zone.
W. C. Medland, Piece Work Inspr., L. S. & M. S. Ry., Elkhart, Ind.
H. Meeder, R. H. F., C. & E. I. R. R., Dolton, Ill.
W. R. Meeder, Gen. Foreman, C. & E. I. R. R., Dolton, Ill.
C. W. Melcher, Western Mgr., Ingersoll Sargent Drill Co., Chicago, Ill.
W. P. Mellon, Valentine Varnish Co., Chicago, Ill.
W. G. Menzel, S. M. P., Wis. Central Ry., Fond du Lac, Wis.
G. W. Merrell, Asst. to G. M., Norfolk & Western Ry., Roanoke, Va.
F. Mertsheimer, G. S. M. P., K. C. M. & O. Ry., Kansas City, Mo.
L. F. Michael, Draftsman, C. & N. W. Ry., Chicago, Ill.
R. Michener, Mgr. Chicago Branch, Crucible Steel Co., Chicago, Ill.
S. W. Midgley, Curtain Supply Co., Chicago, Ill.
C. M. Mileham, 7207 Howard Ave., Chicago, Ill.
C. E. Miller, Locomotive Engr., Indiana, Illinois & Iowa Ry., Kankakee, Ill.
E. C. Miller, Foreman, Pittsburgh & Lake Erie Ry., Glassport, Pa.
F. S. Miller, Machinist, C. B. & Q. Ry., Creston, Ia.
F. W. Miller, Salesman, J. L. Yale & Co., Chicago, Ill.
H. I. Miller, G. M., C. R. I & P. Ry., Chicago, Ill.
P. J. Miller, R. F. E., L. S. & M. S. Ry., Toledo, O.
W. L. Miller, W. L. Miller Heating Co., Chicago, Ill.
S. W. Miller, Supt., American Car & Fdy. Co., Scranton, Pa.
Wm. Miller, Dunmore, Pa.
J. T. Milner, 1407 Fisher Bldg,. Chicago, Ill.
Geo. F. Mills, Niles-Bement-Pond Co., Chicago, Ill.
C. W. Millspaugh, Draftsman, A. T. & S. F. Ry., Chicago, Ill.
W. H. Miner, 669 Rookery Bldg., Chicago, Ill.
A. E. Mitchell, Mgr. Purchases and Supplies, N. Y., N. H. & H. R. R., New Haven, Conn.
H. E. Mitchell, American Locomotive Equipment Co., Chicago, Ill.
J. H. Mitchell, M. E., Pressed Steel Car Co., Chicago, Ill.
J. R. Mitchell, W. H. Miner Co., Chicago, Ill.
W. N. Mitchell, Ry. Dept., International Corr. Schools, Chicago, Ill.
Samuel Moffit, 811 Carroll St., Saginaw, Mich.
C. E. Mohle, Specialist, C. & N. W. Ry., Oak Park, Ill.
G. E. Molleson, Tyler Tube & Pipe Co., New York City.
M. S. Monroe, M. M., Chicago, Lake Shore & Eastern Ry., Chicago, Ill.
W. O. Moody, Chief Draftsman, Ill. Cent. R. R., Chicago, Ill.
N. L. Moon, Supt., Lehigh Valley Ry., Wilkesbarre, Pa.
B. R. Moore, A. S. M. P., Chicago, St. Paul Minneapolis & Omaha Ry., Sioux City, Ia.
C. B. Moore, American Locomotive Equipment Co., Chicago, Ill.
P. W. Moore, Ry. Specialty & Supply Co., Chicago, Ill.
Edw. Moran, Shop Foreman, C. M. & St. P. Ry., W. Milwaukee, Wis.

H. S. Mored, R. F. E., C. B. & Q. Ry., Ottawa, Ia.
O. H. Morgan, Chicago Varnish Co., Chicago, Ill.
A. D. Morris, H. W. Johns Manville Co., Chicago, Ill.
W. S. Morris, 813 Berry St., Fort Wayne, Ind.
T. A. Morris, Loco. Engr., Elgin, Joliet & Eastern Ry., Waukegan, Ill.
T. R. Morris, G. F. C. D., C. M. & St. P. Ry., Chicago, Ill.
H. U. Morton, V. P., National Mfg. & Supply Co., Chicago, Ill.
E. A. Mosely, Secretary, Interstate Commerce Commission, Washington, D. C.
Morris Moskowitz. Commercial Acetylene Co., Chicago, Ill.
J. W. Motherwell, The Ashton Valve Co., Chicago, Ill.
W. B. Moulton, Smoke Inspr., C. M. & St. P. Ry., Evanston, Ill.
C. M. Muchnic, American Locomotive Co., New York City.
H. E. Muchnic, Locomotive Finished Material Co., Atchison, Kan.
Joseph Muhleisen, Loco. Engr., T. St. L. & W. Ry., Elkhart, Ind.
J. E. Muhlfeld, G. S. M. P., B. & O. R. R., Baltimore, Md.
F. T. Mullen, Cont. Frt. Agt., A. T. & S. F. Ry., Chicago, Ill.
J. R Mullen, C. C. M. P. Dept., Chicago, Lake Shore & Eastern Ry., Chicago, Ill.
E. T. Munger, M. M., Metropolitan West Side Elevated R. R., Chicago, Ill.
W. A. Murray, Asst. Engr., New York Central & Hudson River Ry., New York.
John Murrin, Shop Foreman, C. & N. W. Ry., Chicago, Ill.
C. C. Murphy, Standard Railway Equipment Co., Chicago, Ill.
J. P. Murphy, G. S. K., L. S. & M. S., Ry., Collinwood, O.
J. Z. Murphy, Engr., Chicago Union Traction Co., Chicago, Ill.
John Murray, R. H. F., Chicago & Western Indiana Ry., Chicago, Ill.
C. A. Nathan, Nathan Mfg. Co., Chicago, Ill.
C. R. Naylor, T. H. Symington Co., Chicago, Ill.
N. C. Naylor, Railway Steel Spring Co., Chicago, Ill.
J. P. Neff, 525 So. Poplar Ave., Austin, Ill.
J. O. Neikirk, Rodger Ballast Car Co., Chicago, Ill.
C. B. Nelson, Eng. Desp., L. S. & M. S. Ry., Elkhart, Ind.
L. E. Nelson, Pur. Dept., C. M. & St. P. Ry., Chicago, Ill.
W. A. Nettleton, G. S. M. P., C. R. I. & P. Ry.. Chicago, Ill.
G. T. Neubert, M. M., Chicago Great Western Ry., Oelwein, Ia.
J. G. Neffe, Supt. Mach., Ill. Cent. R. R., Chicago, Ill.
W. E. New, M. M., Kansas City Belt Ry., Kansas City, Mo.
G. P. Nichols, Geo. P. Nichols & Bros., Chicago, Ill.
F. H. Niles, Blue Island Car & Equipment Co.. Pullman, Ill.
G. W. Nistle, R. F. D. No. 8, Muskegon, Mich.
R. F. Nixon, Piece Work Inspr., C. B. & Q. Ry., Chicago, Ill.
L. C. Noble, Pittsburgh Steel Spring Co., Chicago, Ill.
J. J. Noland,
Martin Norell, Draftsman, National Dump Car Co., Chicago, Ill.
L. A. North, Machine Shop Foreman, Ill. Cent. R. R., Chicago, Ill.
Geo. Nortman, C. M. & St. P. Ry., W. Milwaukee, Wis.
H. C. Nutt, Gen. Mgr., Nor. Pac. Ry., Tacoma, Wash.
W. H. Nuttall, S. M. P., Manistee & North Eastern Ry., Manistee, Mich.
E. F. O'Boyle,
J. F. O'Connor, W. H. Miner Co., Chicago, Ill.
A. J. Odegaard, Pur. Dept., C. R. I. & P. Ry., Chicago, Ill.
W. F. O'Hara, United States Graphite Co., Chicago, Ill.
Wm. O'Herin, Supt. Mach., Missouri, Kansas & Texas Ry., Parsons, Kas.
E. W. Olds, S. R. S., Milwaukee Electric Railway & Light Co., Milwaukee, Wis.
C. J. Olmstead, Westinghouse Air Brake Co., Chicago, Ill.
O. M. Olson, Spencer Otis Co., Chicago, Ill.
Thos. O'Neal, C. B. & Q. Ry., Lincoln, Nebr.
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Storm Bull

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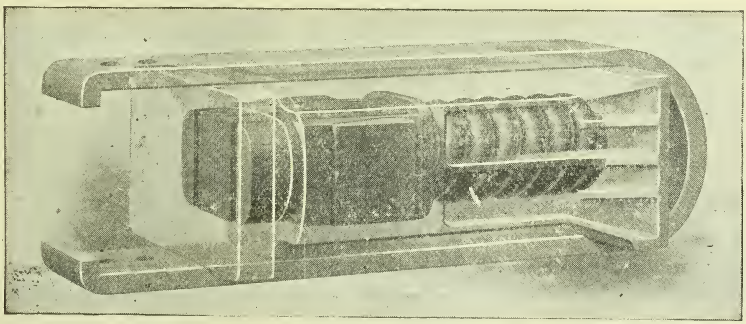

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